Minnesota Department of Transportation

Office of Investment Management
Research Services Section Report

2001-2006

October 2006

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Office of Investment Management
Research Services Section Report

2001-2006

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October 2006

Take the steps...

Research...Knowledge...Innovative Solutions!

Transportation Research

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Purpose

The purpose of this report is to meet the requirements set forth by the Code of Federal Regulations, Part 420—Planning and Research Program Administration—420.117 2(e):

"Suitable reports that document the results of activities performed with FHWA planning and research funds must be prepared by the State DOT or subrecipient and submitted for approval by the FHWA Division Administrator prior to publication. The FHWA Division Administrator may waive this requirement for prior approval. The FHWA's approval of reports constitutes acceptance of such reports as evidence of work performed but does not imply endorsement of a report's findings or recommendations. Report prepared for FHWA-funded work must include appropriate credit references and disclaimer statements."

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Who We Are

Office of Investment Management (OIM)

There are 3 sections within OIM:

Statewide Planning and Analysis Section

Program Development Section

Research Services Section (RSS)

RSS joined OIM in November 2002.

Abby McKenzie is the OIM Director

Research Services Section

Research and knowledge help shape improvements to Minnesota's transportation system.

RSS is charged with acquiring, creating and sharing transportation knowledge.
By meeting the knowledge needs of the transportation community, the Research Services Section supports the Minnesota Department of Transportation's mission to deliver safer, more convenient ways of moving people and goods.

www.research.dot.state.mn.us

Mn/DOT Library

The Mn/DOT Library is within RSS and supports the activities of the Department of Transportation, including the planning, design, construction and maintenance of the state's transportation programs and facilities by providing transportation officials and practitioners information faster, better and cheaper than they can for themselves. The library develops and participates in local, regional, national and international networks to facilitate information exchange between libraries and within the transportation community.

www.dot.state.mn.us/library/

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Director's Message

I invite you to learn more about the Research Services Section through the compilation of this 5 year report.

Included are descriptions of our various programs, partners, and performance measurements. Also included are the research and implementation projects that were completed during the 5 year period from 2001-2006 and current active projects.

RSS manages the Research Program for Mn/DOT through the Office of Investment Management.

RSS consists of the Research Development and Project Management unit, Financial Services Unit, Research Implementation, Outreach and Marketing Unit, and the Mn/DOT Library.

Sue Lodahl, Director
Research Services Section

sue.lodahl@dot.state.mn.us

Staff Contacts

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Previous Employees

A big "Thank You" to those who worked in RSS and the Library during 2001-2006. The work in this report could not have been completed without you.

Al Schenkleberg was the Director of OIM from 1993 to 2006. He started Mn/DOT in 1969 in West Metro (old District 5). He worked at Mn/DOT for 37 years before retiring in December of 2006.

Dave Johnson worked in RSS from 1994 to 2004. He began as a Technology Development Engineer in 1994 and was the Director of RSS upon leaving the department in 2004 to join the Office of Materials. He retired from Mn/DOT July of 2006.

Jim Aamot
Information Technology Specialist, RSS

Susan Andrews
Circulation Clerk, Library

Joanna (Schedin) Bejarano
Receptionist, RSS

Lourdis Benavides
Routing/Periodicals Clerk, Library

Ken Buckeye
Planning Director—State, RSS

Karen Billiar
Financial Services Manager, RSS

Bill Bunde
Research Implementation & Evaluation Coordinator, RSS

Ron Cassellius
Research Program Coordinator, RSS

Margie Grilley
Technology Transfer Librarian

Heather Holt
Financial Services Support, RSS

Mary Johnson
Routing/Periodicals Clerk, Library

Adeel Lari
Director

Dawn Lee
Routing/Periodicals Clerk, Library

Barb Loida,
Program Development Engineer, RSS

Anne Mackereth
Technology Transfer Librarian

Pam Newsome
Public Services, Library

John Pantelis
Circulation Clerk, Library

Micky Ruiz
Technology Transfer Manager, RSS

Mukhtar Thakur
Director

Mission Statements

RSS supports measurable improvements in Minnesota's transportation system by meeting the knowledge needs of transportation practitioners and the transportation community.

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The Mn/DOT Library brings together the staff, equipment and materials needed to provide access to knowledge by alerting, guiding, advising and assisting individuals from the transportation community so that they are more fully informed.

Key Facts

- RSS produces approximately 40 to 50 reports a year.
- Mn/DOT Library is one of the leading state transportation agency library in the country.
- Mn/DOT Library is recognized internationally as a leader in developing return-on-investment analyses of library operations and has demonstrated a benefits/cost ratio of at least 12:1 as a result of services provided to the department.
- Mn/DOT Library is a leader in the cataloging of online, electronic resources providing access to more than 1,400 online documents, or more than 8% of all resources in its catalog, a greater number and percent than any other transportation library.
- Requests for RSS products have tripled over the last two years due to our focus on development of user-friendly products such as field guides, interactive design tools and our web sites.
- RSS on average manages 125 active contracts.

Customer Feedback

"Recently I checked out two FHWA Technical Reports from the library. I needed to research these reports in a hurry for technical guidelines. The T2 Center in Fargo did not have these reports on hand and it would have taken several weeks and several dollars to obtain these reports from the U.S. Government Printing Offices. The library mailed the reports immediately and I was able to do the research in a timely manner."

- (MN County Engineer)

"You have provided (1) Literature searches--helped me for a speech in Taiwan; (2) Publications that were not available at my agency--saving me time in ordering and enormous amounts of money (that we may not have had to spend) especially TRB, but also AASHTO, ITE and others; (3) Contacts/addresses/telephone numbers: Invaluable. Saved us lots of time. Your office/services are invaluable for those of us in transportation who don't work for a transportation agency."

- (MN State Employee)

"The [library] has been tremendously helpful to me...a lot of information would be unknown or inaccessible to me without this service. I cannot think of a situation where you were not able to provide information or services that I have requested."

- (Mn/DOT Employee)

What We Do

Research Services

Management:
Sue Lodahl
Responsible for the day-to-day operations of Mn/DOT's and the Local Road Research Program's research programs. Builds relationships with upper management, other offices, and external customers. Holds a board member position on the LRRB and is a member of many other steering and advisory committees, including Mn/DOT's state Transportation Research Board representative.

Administrative Support:
Linda Christen
Provides administrative support to RSS and the Library.

Information Technology:
Nelson Cruz
Programmer, analyst and project manager for the Information Technology systems that support the research programs. The custom systems include several tracking databases and two main web sites with two supplementary web sites. Another major role is to act as a technical consultant for leveraging IT when applicable, and for IT implementations resulting from the research programs.

Research Management:
Jim Klessig, Ann McLellan, Clark Moe, Alan Rindals, Shirlee Sherkow, Dan Warzala
Identifies needs and project coordination for the Mn/DOT and LRRB research programs. It also includes coordinating state and national cooperative research programs, including coordination of the Transportation Pooled Fund program.

Maintains contact with clients through regularly scheduled events such as quarterly LRRB meetings, quarterly Center for Transportation Studies partnership meetings, quarterly CTS council meetings, statewide research coordinator meetings, functional area focus groups and yearly project orientation meetings.

Provides Administrative Liaisons for all Mn/DOT and LRRB research projects to ensure that contracts are followed and deliverables are submitted.

Financial Services Section:
Sue Kahle, Kay Lowe, Carole Wiese
Coordinates research contracts and funding processes including contract creation, budget management, and local, state, and national research funding coordination.

Research Implementation, Outreach, and Marketing:
Linda Christen, Sandy McCully, Ann McLellan, Clark Moe
Aims at the practical application of research results. Coordinates report publishing, training, new technology development, identifies impacts of research investments, and performance measurement and evaluation of Mn/DOT's research program. Responsible for communications planning, marketing, and outreach for Research Services and LRRB.

Maintains contact with clients through regularly scheduled events such as quarterly Research Implementation Committee meetings, the annual Implementation Funding Program, and the annual Spring Maintenance Expo. Communicates through the bimonthly RSS Newsletter and maintains the RSS web site and LRRB web site. Coordinates the publishing of research reports, brochures, instructional videos, CDs, and manuals.

www.research.dot.state.mn.us

www.lrrb.org

What We Do

Mn/DOT Transportation Library

Transportation Library:

Library Director:
Jerry Baldwin

Reference Liberian:
Jim Byerly

Technical Services Librarian:
Qin Tang

Library Technicians:
Barb Hogan, Olive Nerem

Library Clerks:
Linda Christen, Pam Gonzalez

Mn/DOT Library brings together the information resources, services and equipment required to provide timely access to information needed by those who plan, design, build, operate and maintain the state's transportation infrastructure. It also establishes and participates in a wide range of partnerships and networks, including the Capitol Area Library Consortium, Midwest Transportation Knowledge Network, MINITEX and OCLC, to access and share information resources on local, state, regional and international bases. Library staff identify reports and other information resources produced by Mn/DOT and create descriptions of these resources for inclusion in databases accessed by researchers around the world. The staff also assist Mn/DOT research staff in framing questions, and identifying and acquiring information resources related to those questions. As an element of the state's Local Transportation Assistance Program, in collaboration with the University of Minnesota's Center for Transportation Studies, it extends these resources and services to transportation officials and practitioners throughout Minnesota.

Mn/DOT Library
Your Local Connection To Global Information

www.dot.state.mn.us/library/

Partnerships

Research Services partners with federal and local government agencies, other Mn/DOT offices, universities, and other entities. The partnerships Research Services have with these entities help create the program that exists.

Local Road Research Board

Established in 1959 through state legislation, LRRB has sponsored more than 200 individual research projects on a variety of topics. Current LRRB-funded research falls primarily into the following categories: design, construction, maintenance/operations, environmental compatibility, administration, and implementation.

Funding is up to one-half of one percent of state aid allocation. The funding level for Calendar year 2005 was $2,346,760.

Local engineers submit ideas to the LRRB who selects and approves proposals. Researchers from Mn/DOT, universities, and consulting firms conduct the research and the LRRB monitors the progress. Research Services provides administrative support and technical assistance by holding focus groups to obtain research ideas, coordinating the project selection process, creating the contracts, and holding administrative liaison positions on projects. In addition, Research Services staff coordinate the LRRB meetings, the budget, and the web site.

The Board consists of two city engineers, four county engineers, three Mn/DOT managers, and the U of M Center for Transportation Studies Director. Staff provided by CTS and Mn/DOT RSS.

The LRRB supports Local Operational Research Assistance Program (OPERA), Local Technical Assistance Program (LTAP), and the Research Implementation Committee (RIC).

The LRRB also funds RSS (research administration and Library staffing) and MnROAD activities.

Research Implementation Committee

The LRRB recognizes the importance of moving research results into practice. The LRRB works through its RIC to make information available and to transfer results into practical applications for city and county engineers. The RIC and its staff coordinate implementation task development.

Research Services Section provide support services, including coordination of the project selection progress, creation of the contracts, and administrative duties on projects. Also, RSS coordinates the evaluation of the applied impact of the research.

The funding level for Calendar Year 2005 was $200,000.

The RIC uses a variety of media to reach engineers and others with new developments including: CD-ROMs, videotapes, DVDs, written reports, brochures, seminars, workshops, field demonstrations, presentations, and the LRRB website.

RIC members include four county engineers, two city engineers, the Mn/DOT Assistant State Aid Engineer, a Mn/DOT District State Aid Engineer, a Mn/DOT RSS representative, a Mn/DOT of Materials representative, and a University of Minnesota, CTS representative.

Partnerships

RSS is involved in partnerships with various entities. The following few pages describe these partnerships.

Transportation Pooled Fund

When significant or widespread interest is shown in solving transportation-related problems, research, planning, and technology transfer activities may be jointly funded by several federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms as a pooled fund study.

To qualify as a pooled fund study, more than one state transportation agency, federal agency, other agency such as a municipality or metropolitan planning organization, college/university or a private company must find the subject important enough to commit funds or other resources to conduct the research, planning, and technology transfer activity. If a subject has been studied previously, the new study should provide new information that will complement or advance previous investigations of the subject matter.

A federal, state, regional, or local transportation agency may initiate pooled fund studies. Private companies, foundations, and colleges/universities may partner with any or all of the sponsoring agencies to conduct pooled fund projects.

Transportation Research Board

The Transportation Research Board (TRB) is a division of the National Research Council, which serves as an independent adviser to the federal government and others on scientific and technical questions of national importance. The mission of the TRB is to promote innovation and progress in transportation through research.

Mn/DOT works with the TRB to help improve the design, construction and operation of public highways through research. TRB serves as a clearinghouse for the exchange of technical information, reducing duplication of effort and allowing agencies to build on the work of others.

The TRB holds an annual meeting in Washington, D.C. and committee meetings throughout the year. The meeting are a chance for engineers, scientists and other transportation researches and practitioners from the public and private sectors and academia to meet to exchange information on projects that are of national importance.

Minnesota was represented by Mn/DOT and academia during sessions and committees at the 2006 TRB Annual Meeting. The first annual "TRB Minnesota Guide" was prepared in 2006 and contains information on the sessions that Minnesota practitioners presented at and the committees they are involved with. The "Minnesota Guide" is available at http://www.research.dot.state.mn.us/newsletter/TRB%20Minnesota%20Guide.pdf More information on the TRB is available at http://trb.org/.

Partnerships

Other Mn/DOT Offices

Research Services Section solicits problem statements from other Mn/DOT offices. Problem Statements detail problems that offices would like to have answers provided via research. Proposals are solicited and Mn/DOT Office Directors rank the proposals. Once funded, the problem statement providers become Technical Liaisons (TL). TLs ensure that the agency's interest is being met throughout the research project. The following are Mn/DOT offices that work with RSS:

Aeronautics	Construction and Innovative Contracting
Environmental Services	Freight and Commercial Vehicle Operations
Transit	Land Management
Bridges	Materials
Technical Support	Maintenance
Transportation and Data Analysis	Traffic, Security and Operations
State Aid	

Other Mn/DOT Office Programs

Other Mn/DOT offices have research programs of their own. Research Services works with these programs in various capacities including providing Administrative Liaisons (ALs) for research projects, and creating contracts.

Minnesota Road Research (MnROAD) - Office of Materials

- MnROAD is the world's largest and most comprehensive outdoor laboratory designed to improved the quality and value of the Minnesota Road Research System while reducing future taxpayer costs by extending pavement life.

Transportation Engineering and Road Research Alliance (TERRA) Board - Engineering Services Division

- TERRA is a research governance formed to foster a comprehensive road research program. A strategic focus is to take greater advantage of the MnROAD test facility and associated resources. Mission is to develop, sustain, and communicate a comprehensive program of research on pavement, materials, and related transportation engineering challenges including issues related to cold climates.

Minnesota Guidestar/Intelligent Transportation Systems (ITS) - Office of Traffic, Security and Operations

- ITS' mission is to research, test, and deploy advanced transportation technology to save lives, time, and money.

Maintenance Research - Office of Maintenance

- Maintenance Research's purpose is to promote innovations in Mn/DOT operations and maintenance by stimulating and conducting research in areas of winter maintenance, road and bridge maintenance, building maintenance, operations management, roadside maintenance, general maintenance, work zone safety, and technology transfer.

Pavement Research Institute—Office of Materials

- The Pavement Research Institute was established at the University of Minnesota to bring together multi-disciplinary, collaborative research teams to tap the full range of Federal funds available to academic programs and state agencies to ensure a strong and continuous pavement research effort and ultimately become a self-sustaining program.

Partnerships

Universities

Universities provide RSS with Principal Investigators. PIs respond to problem statements by creating proposals to address problems. If funded, PIs perform the research while working with Administrative Liaisons and Technical Liaisons.

Simplified, RSS coordinates the Request For Proposal process with universities, creates contracts, and provides ALs for research projects.

The University of Minnesota and Minnesota State Colleges and Universities both view problem statement prior to out-of-state universities.

University of Minnesota

- Largest transportation research facility in Minnesota

Center for Transportation Studies

CTS partners with RSS in the Request For Proposal process, U of M Project Orientation, quarterly Partnership meetings, subcommittee Partnership meetings, and publishing of final deliverables and with many other special projects.

University of Minnesota—Duluth

Northland Advanced Transportation Systems Research Laboratories

Minnesota State Colleges and Universities (MnSCU) - 37 public institutions

RSS is currently contracting with:

Bemidji State University
Mankato State University
St. Cloud State University

Out of State Universities

Iowa State University's Center for Transportation Research and Education
Michigan State University
Michigan Technological University
Pennsylvania State University
University of Illinois
University of North Dakota
University of Northern Iowa
University of Wisconsin - Madison

Partnerships

Other

RSS is also involved with the following programs:

Airport Technical Assistance Program (AirTAP)

AirTAP's goal is to increase knowledge by public and private airport professionals of new technology and techniques for designing, maintaining, operating, and administering small airports to improve service delivery. Overall this should result in an improved public image of local agencies and airport operation, which have a positive impact on the community.

Circuit Training and Assistance Program (CTAP)

CTAP provides training in the latest transportation-related technologies to personnel from townships, cities, counties, and the state.

Center for Transportation Studies Operations (CTS)

Mn/DOT provides base funding to CTS as mandated by Minnesota Statutes 2005, Section 161.53 to create an environment within the University or faculty, students and practitioners from multiple disciplines to collaborate in transportation research and education efforts.

Minnesota Local Technical Assistance Program (MNLTAP)

Minnesota LTAP is designed to provide local agencies with the tools—training, events and conferences, technology transfer, resources and personalized assistance—for improving their transportation operations. CTAP and OPERA are a part of this program

Operational Research Program for Local Transportation Groups

OPERA aims to promote innovations in operations and maintenance methods, materials, and equipment for a safer, more efficient and environmentally sounds statewide transportation system. The program will fund projects up to $10,000.

Pavement Research Institute

Exists to develop and establish a Pavement Research Institute that will bring together multi-disciplinary, collaborative research teams to tap the full range of Federal funds available to academic programs and state agencies to ensure a strong and continuous pavement research effort and ultimately become a self-sustaining program.

Research Publication and Outreach Services

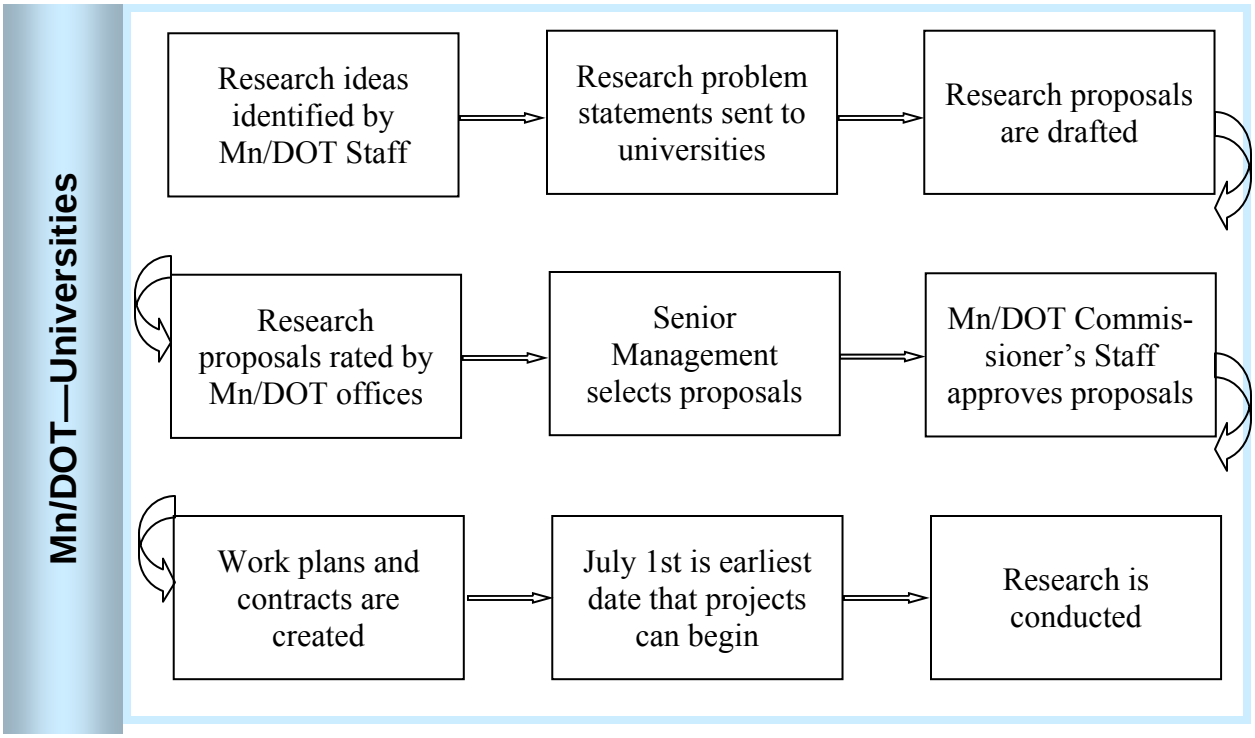
Mn/DOT's Research Services Section contracts with CTS in the areas of publishing and disseminating research results.

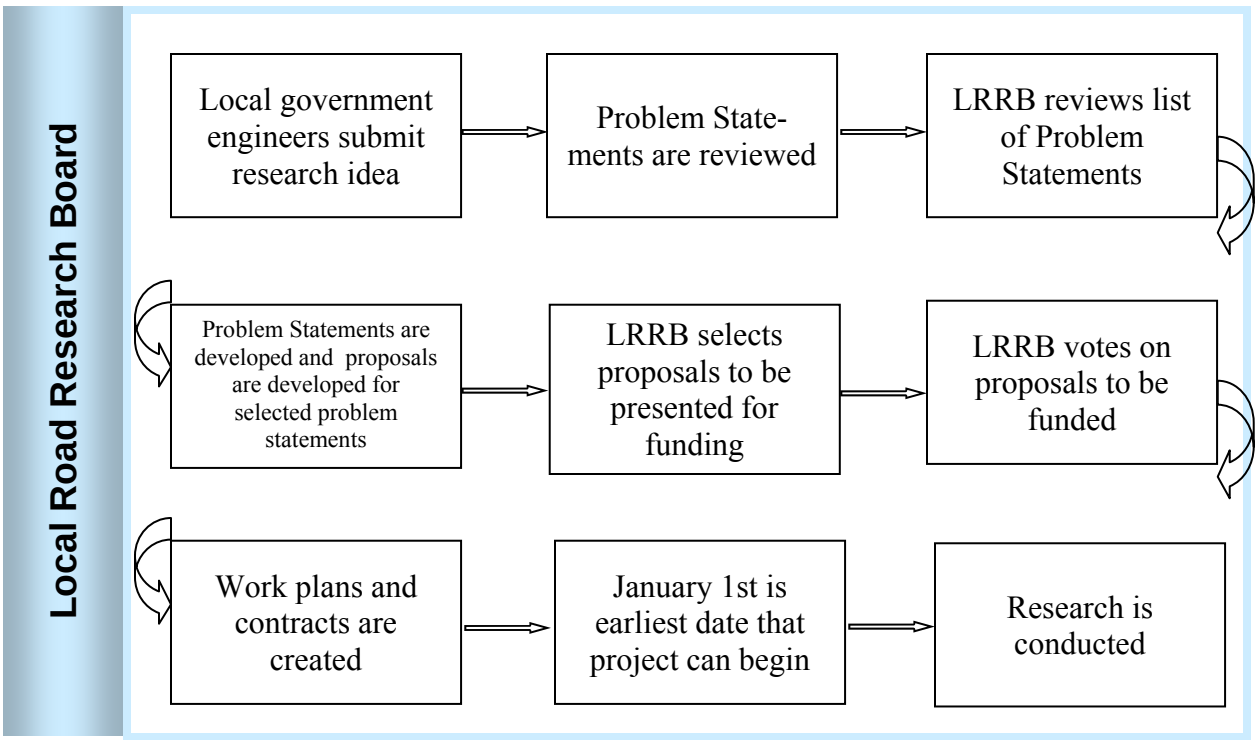
Web Site Maintenance

Research Services works with a contractor who provides web site and database maintenance for the LRRB and RSS web sites.

Project Selection

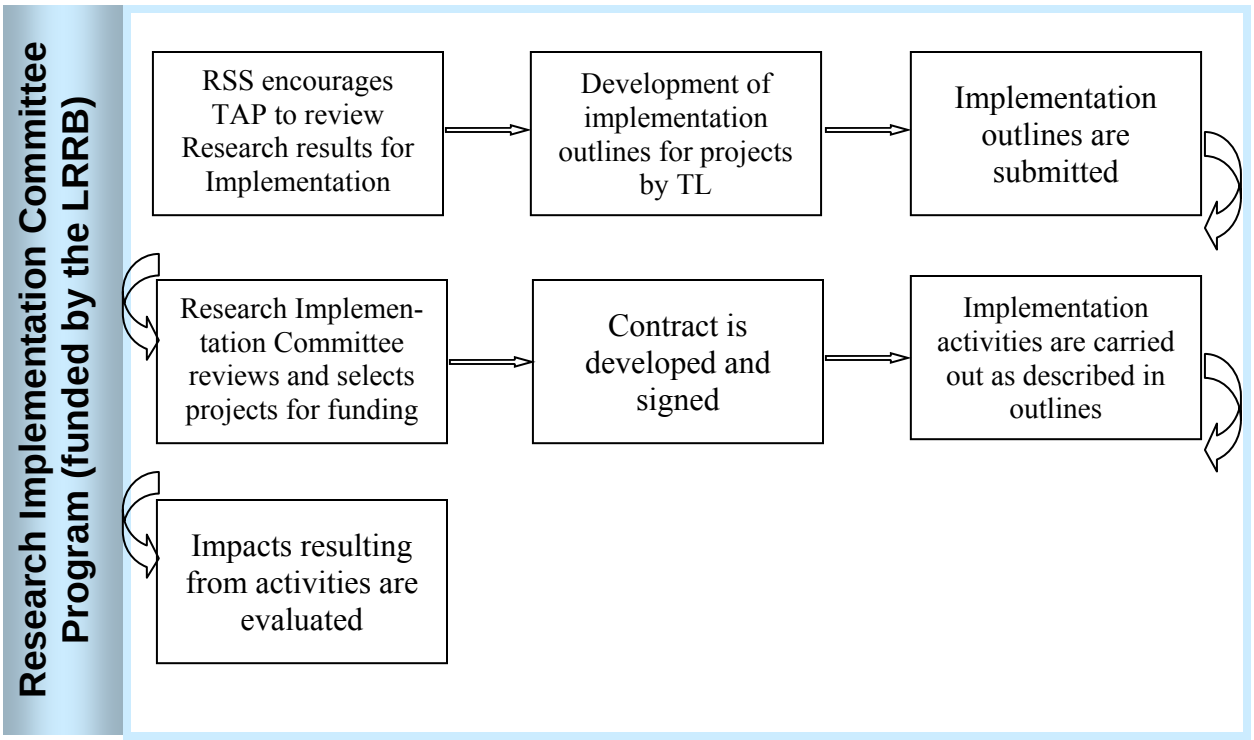
Every program dealing with projects that is administered by RSS has a project selection process.

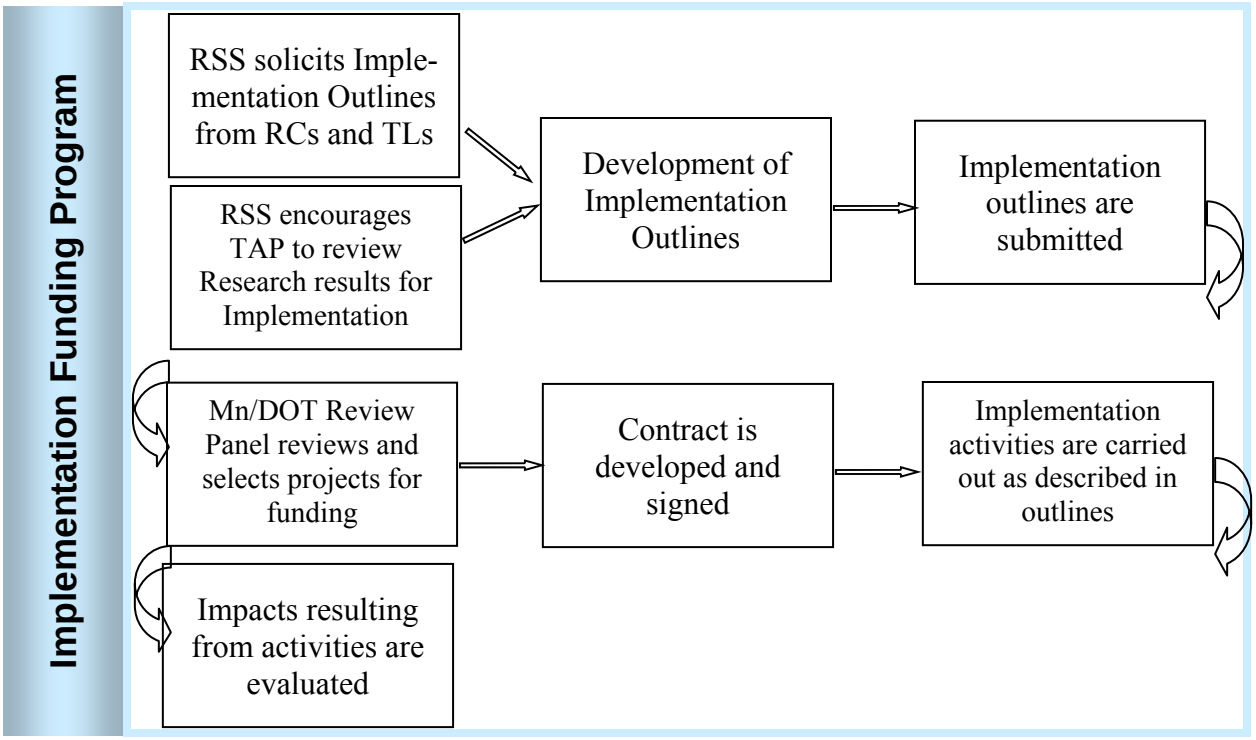




Project Selection

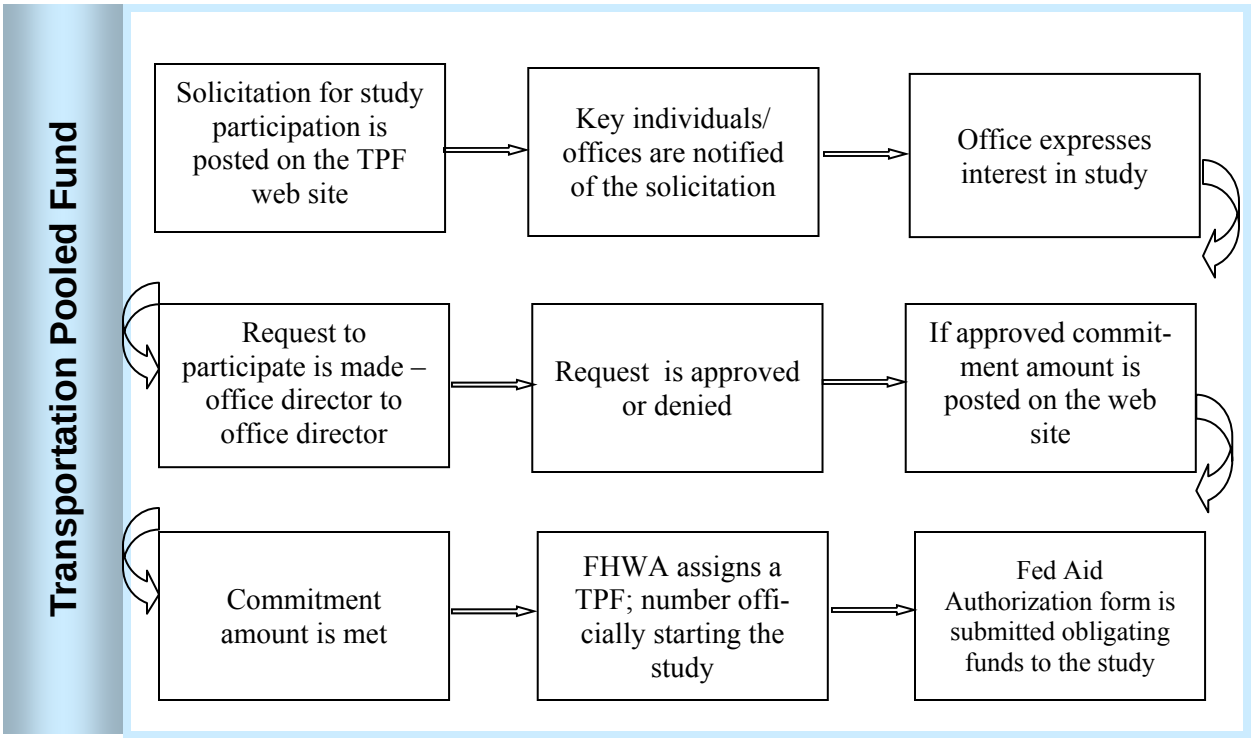
The goal of the research implementation programs is to encourage and support activities that apply research results in ways that *measurably* improve the performance of agency investments of transportation

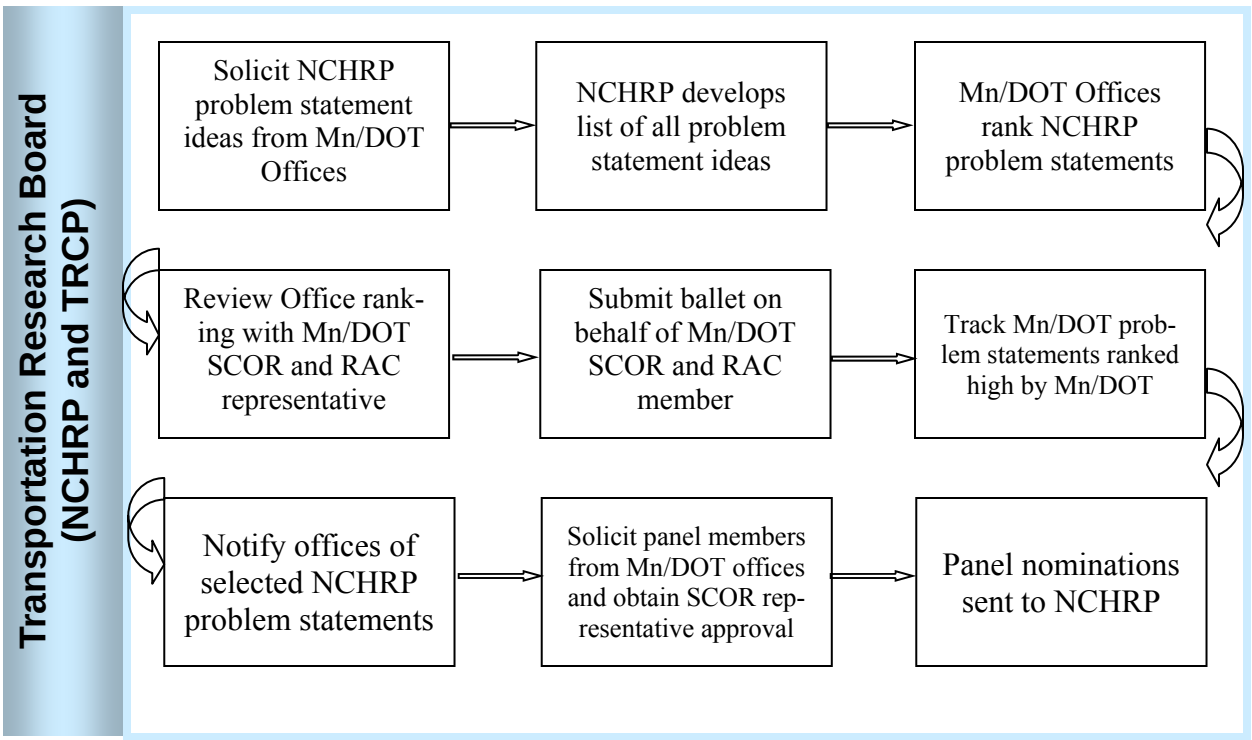




Project Selection

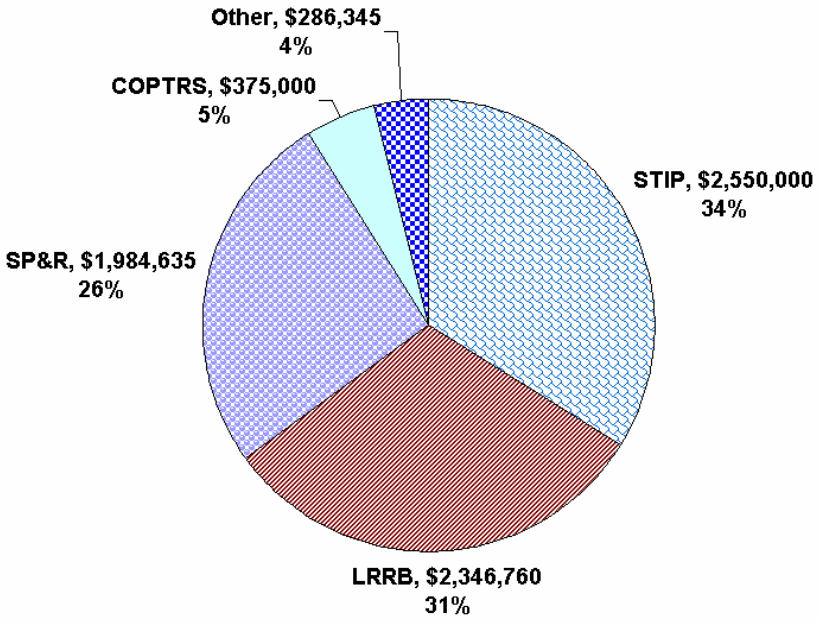
The following two diagrams illustrate the internal Mn/DOT process for these national programs:





Where the Funding Comes From

In calendar year 2005, the funding sources for research projects and implementation are illustrated in the chart below.



Key

STIP =	State Transportation Improvement Program
LRRB =	Local Road Research Board
COPTRS =	Cooperative Program for Transportation Research and Studies
SP&R =	State Planning and Research

Getting the Word Out

RSS provides various services and produces a variety of products. The following two pages describe the programs that strive to convey our services and bring the products to the people who will benefit from using them.

Implementation Funding Program

Mn/DOT's Research Implementation Funding Program supports the application of results from Mn/DOT research projects. Successful implementation occurs when practical benefits are realized by the application of research. The goal of the Research Implementation Funding Program is to encourage and support activities that apply research results in ways that measurably improve the performance of Mn/DOT's investments in transportation resources. Projects should support Mn/DOT's Strategic Plan.

Research Services solicits implementation proposals from Mn/DOT. A six-member panel representing diverse functional areas within Mn/DOT reviews and approves funding proposals for this program.

Proposals are welcomed from disciplines throughout Mn/DOT for the application of research findings and current technology at all levels. Implementation projects may include the production of reports, brochures, videos, CD ROMs, training programs, and more.

Research Implementation is achieved when the results are applied and practical benefits are realized.

This program is administered by Mn/DOT with STIP funds.

Conferences & Events

RSS Participates in

Minnesota Spring Maintenance Training Expo—April, St. Cloud

Project Orientation—March/April, Various locations

CTS Transportation Research Conference—May, St. Paul

Research Coordinator Meetings—Spring and Fall, Various locations

CTS Partnership Meetings– Quarterly

CTS Council Meetings—Quarterly

Upcoming:
Strategic Visioning Seminar

RSS Supports

Transportation Research Board - January, Washington D.C.

Minnesota Fall Maintenance Training Expo—October, St. Cloud

Pavement Management Conference—February, St. Paul

CTS Transportation Research Conference—May, St. Paul

Northland Advanced Transportation Systems Research Laboratories (NATSRL) - November, Duluth

Getting the Word Out

Marketing and Outreach Program

The Marketing and Outreach program is charged with delivering and communicating RSS' services and products to a variety of customers including: State and Federal personnel, LRRB members, City and County Engineers, and university transportation practitioners.

Through these programs:

- Research results are circulated.
- Research project results are condensed into summary format for easier viewing.
- Research reports are published and disseminated.
- Marketing materials connect users with RSS and LRRB program services.

  Examples include:
  Newsletters, trading cards, informational sheets, business cards, brochures, promotional materials, web sites, research reports, DVDs, annual reports, banners, posters, conference booths, etc.

Web Sites

Three web sites are administered by the Research Services Section:

Mn/DOT:

www.research.dot.state.mn.us

www.dot.state.mn.us/library

LRRB:

www.lrrb.org

Performance Measures

RSS produces an annual Performance Measurement report. The full report can obtained by calling RSS.

Research Services Section

Research Services

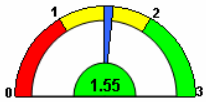
The Results of Implemented Research

The outcomes of closed out implemented research projects are graded on a scale of 0 to 3 by the close-out memo author.

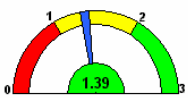
Trend Color:
GREEN = improving trend.
YELLOW = static or stable condition.
RED = deteriorating trend.

Scale:
3 change, with measures
2 change, without measures
1 knowledge gained
0 not useable

2005



2004



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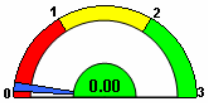

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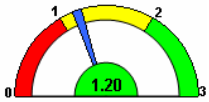

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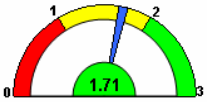
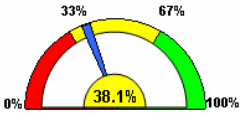


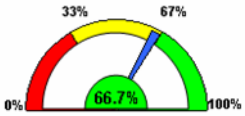
Research Implementation Planning Effort

Percentage of Implementation Plans received for completed research projects.

2005



2004



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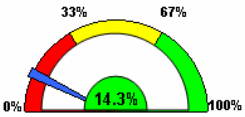

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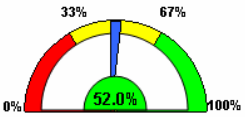

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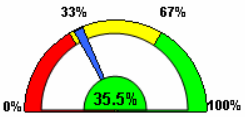
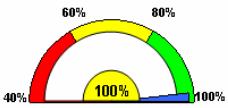


The Percent of Funded Research Proposals Addressing a Strategic Goal

Percentage of funded research projects that address one or more of the Mn/DOT or LRRB strategic goals. Starting in 2004, proposals were linked to the "Minnesota Statewide Transportation Plan 2003-2023 – Policies and Performance Measures" matrix. Before being considered for funding, the proposal had to identify how the results could address the "Minnesota Statewide Transportation Plan 2003-2023 – Policies and Performance Measures" matrix.

2005



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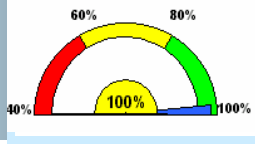

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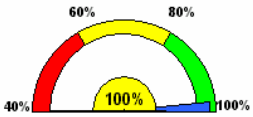
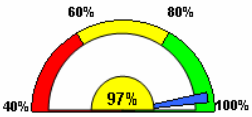


2002



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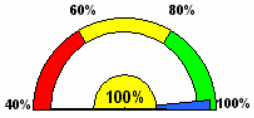


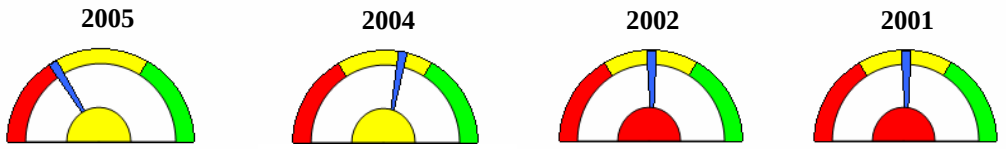
Performance Measures

Mn/DOT Transportation Library

Research Services

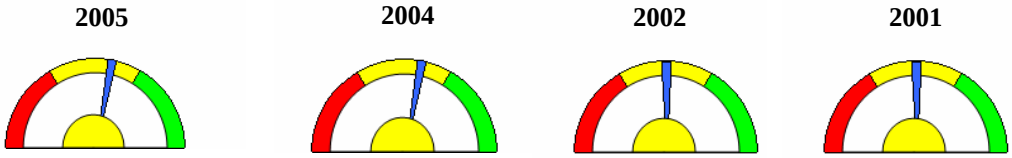
Library Responsiveness

The ability to provide the customer with needed information within the timeframe set by the customer.



Library Collections (and Organization)

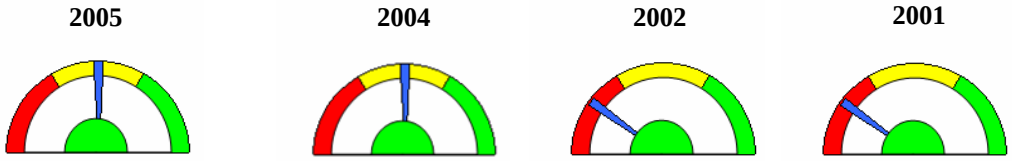
The ability to acquire and organize Mn/DOT information resources that are needed by our customers.



Transportation Library Access

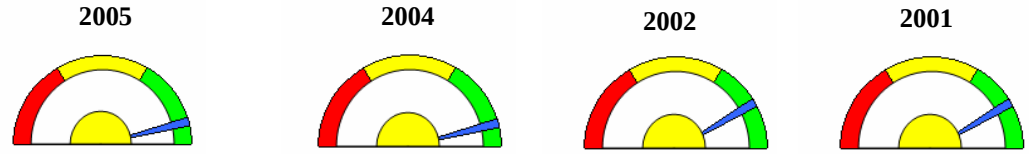
(Availability of Resources from a Network of Transportation Libraries)

The ability to identify and acquire transportation-related resources from other sources on an as-needed basis.



Library Market Penetration

Percentage of potential primary customers actively using library services in comparison with other special libraries.



Product Evaluation Program

Mn/DOT created a Product Evaluation Committee in 2005 to develop a new centralized process for managing the review of various products. This committee is comprised of experts from various functional offices within Mn/DOT. The committee is in the process of developing a recommendation.

The purpose of the program is to evaluate vendor's products to determine if using a product is beneficial to Mn/DOT and to determine if use of the product may incur undue liability for the department. Until recently, the process was decentralized, meaning that vendors would contact individual offices for evaluation of products. An automated, centralized system is currently being developed by the committee.

The objectives of the committee are to:

1. Provide a uniform process for vendors to submit products to Mn/DOT for inclusion on the Approved Products List.
2. Provide a central Approved Products List accessible by internal personnel and external vendors.
3. Provide a single point of contact for product approval.
4. Ensure that product reviews are conducted by all appropriate offices within the department.

The Mn/DOT Product Evaluation Committee recommends the following:

- Focuses only on the following three main categories:
  - Traffic Safety
  - Construction Materials
  - Maintenance Materials
- Existing manufactured products only; no prototypes.
- Products that are being researched and developed will not be evaluated.
- Supplies, facility, and fleet products will not be evaluated.
- Equipment will not be evaluated.

This program provides a way for products to be placed on the Approved Products List, but not the research and development of products. A link will be created to allow a vendor to contact the appropriate evaluator.

A web site will be created that vendors can enter from Mn/DOT's web site. While in the product evaluation web site, vendors can enter product information into the product evaluation system. From the system, the information will be sent to evaluators for evaluation. An Approved Products List will be accessible from the web site. The Offices of Information Technology and Communications are both involved in developing this web site.

Currently, vendors are to contact RSS for product evaluation submittal and processing. Please contact Ann McLellan at 651/282-2692 with questions.

Long-Term Research Success Story

Over forty years of knowledge has accumulated into the "Best Practices for the Design and Construction of Low Volume Roads Manual" and "Hot Mix Asphalt Design Tool". These projects are good examples of how together, research and implementation enhance a project and the people from various organizations can work together.

In 1999, the Local Road Research Board funded an initial project titled "Best Practices for the Design and Construction of Low Volume Roads". The following two consecutive years, the LRRB funded two more related projects "Traffic Supplement to Low Volume Roads Best Practices Manual" and "Design and Construction of Pavement Embankments in Minnesota", each became a chapter in the manual. Dr. Gene Skok, University of Minnesota, was the principal investigator.

The manual was developed to present methods of design and construction of Hot Mix Asphalt (HMA) pavements in Minnesota. Mn/DOT and the flexible pavement industry are now in a time of transition for thickness design and construction procedures. The MnPAVE thickness design procedure is a mechanistic-empirical computer software program that takes into account many variables that could not be considered previously. The performance of 40-year old test sections has been used to check the performance prediction equations used in MnPAVE.

Three procedures are now available for us in Minnesota: the Soil Factor Procedure, the Stabilometer R-Value and the mechanistic-empirical procedure (MnPAVE).

The current procedures have been used over the past 25 plus years. It is recommended that: 1) the current procedure of choice (Soil Factor or R-Value) be used to establish a thickness design or alternative designs, 2) the MnPAVE software be used to establish alternate design(s), 3) send comparisons to the Mn/DOT Road Research Section and 4) if new materials or existing materials are used in a different way, set up designs using MnPAVE and report the results.

In 2002, training materials and a CD containing the MnPAVE software, and PowerPoint presentations were used by Dr. Gene Skok and Shongtao Dai, Mn/DOT Office of Materials, to present at the Minnesota County Engineers Association Meeting. Training sessions were given at the Maplewood Lab and then in each Mn/DOT district.

This project received Honorable Mention for the 2004 Center for Transportation Studies Research Partnership Award.

Best Practices for the Design and Construction of Low Volume Roads $155,000
Technical Liaison: Dave Van Duesen — Mn/DOT Office of Materials
Administrative Liaison: Ann McLellan — Mn/DOT Research Services Section
www.lrrb.gen.mn.us/pdf/200217REV.pdf — Report #2002-17REV

Traffic Supplement to Low Volume Roads Best Practices Manual $24,997
Technical Liaison: Kevin Howieson — Mn/DOT/State Aid Baxter District
Administrative Liaison: Dan Warzala — Mn/DOT Research Services Section

Design and Construction of Pavement Embankments in Minnesota $105,625
Technical Liaison: Lou Tasa — Mn/DOT/State Aid District Bemidji
Administrative Liaison: Dan Warzala — Mn/DOT Research Services Section
www.lrrb.gen.mn.us/pdf/200336.pdf — Report #2003-36

Implementation

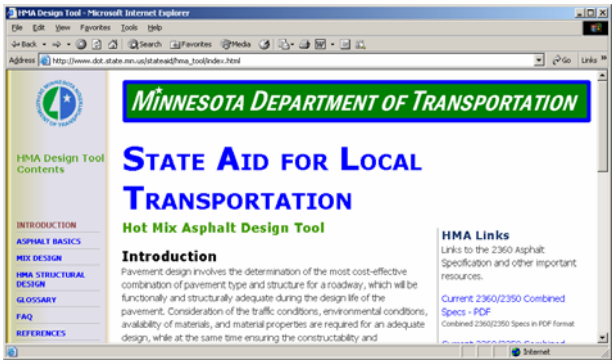
Due to the ever changing nature of pavement design, the manual would have to be updated continually. Instead, the Local Road Research Board funded a project through their Research Implementation Committee to revamp the Asphalt Paving Guide Web site with the manual information.

Low Volume Road/Hot Mix Asphalt Design Tool $27,780

Michael Marti, SRF Consulting Group, Inc.
Dave Johnson, Mn/DOT Office of Materials
Clark Moe, Mn/DOT Research Services

www.dot.stae.mn.us/stateaid/hma_tool/index.html

Project Description: This task called for the conversion of the best practices to a Web-based, interactive user application. It salvaged and replaced the useful portions of the existing Asphalt Pavement Guide into the new web application. This Web application will allow updates to be easily made as new research and specifications become available.



Hot Mix Asphalt Design Tool

Mn/DOT State Aid

Mn/DOT's State Aid Office is working with LTAP to ensure continual updating of the Web site.

A training course was created through Minnesota's Local Technical Assistance Program (LTAP) to train civil engineers and technicians.

Best Pavement Design Practices for City Streets and County Roads

Jim Grothaus,
Center for Transportation Studies, LTAP

www.mnltap.umn.edu/workshops/roadway-bridge/roadway-bridge11.html

This workshop outlines best practices for pavement design on city and county roadways. All three accepted methods of pavement design will be covered, including soil factor and R-value thickness and an introduction to MnPAVE for thickness design.

Long-Term RIC (LRRB) Success Story

One of the most requested products from Research Services is the Snowplow Cool! Video. In 2001, it won the National Association of Government Communicators' Gold Screen Award of Excellence - 3rd Place.

This video presents a lesson for 2nd and 3rd grade children on safety around snowplows. The kit includes a 9-minute video, lesson plan, and worksheets to facilitate learning and retention and communication of the lessons to parents. City and county public works departments are encouraged to visit schools in conjunction with this video to build connections with their communities and take an active role in safety.

The video relates the story of Donnie and Althea, 10-year old neighbors, who had a near-accident with a snowplow. The snowplow bears down on them as they hide in their "fort" near the street. Luckily, the driver sees their sled and shovels and suspects trouble. The plow stops just in time. Donnie and Althea tell what they learned from the plow driver about snow safety. The video also addresses safety while sliding and waiting for the school bus.

This project was funded through the Local Road Research Board's Research Implementation Committee's 1999-2000 RIC program . The cost was $51,860.

In December of 2001, 725 video packets were distributed to city and county engineers and schools. A survey was included with the video for city and county engineers and teachers to complete and send in after the video is presented in class. To date, 112 surveys have been received; 20 by city and county government and 92 by schools. An abbreviated selection of comments from the survey were:

CITY AND COUNTY ENGINEERS responses:

- Shown 50 times on cable (6,200 subscribers).
- Showed to Cub Scouts.
- Will show during School Tours at City Hall.
- The schools were contacted, but did not wish to use at this time.
- Equipment operators showed video at schools.

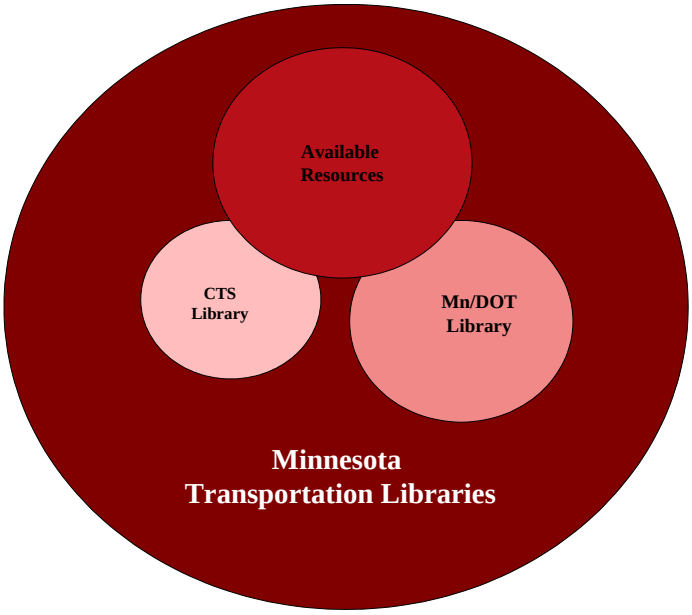
SCHOOL TEACHERS responses:

- Will show every year K - 6; liked safety suggestions.
- Worked well for kindergarten aged kids.
- A+; Did not use worksheet; Video in other languages?
- Covers 7 cities, 16 - 20 meetings a month. Looking for more and longer videos.
- Maybe list tips as the people are talking about them. More action.
- The video was excellent, held the student's interest and gave an important message.
- Sometimes I thought the children in the video were speaking too fast.
- This is important information for our population of youngsters. We have a growing group of English as a Second Language (ESL) kids who's parents have never experienced snow and don't know the dangers.

Principal Investigator:	Cameron Kruse, Braun Intertec Corporation
Implementation Coordinator:	Mark Maloney, City of Shoreview
Implementation Liaison:	Clark Moe/Ann McLellan, Mn/DOT Research Services Section
Product Identification:	VT TD868.S66

Long-Term Library Success Story

Minnesota Transportation Libraries (MTL) is a program that developed as a result of the partnership between the Research Services Section and the Center for Transportation Studies (CTS) at the University of Minnesota. Partially funded by the Minnesota Local Road Research Board, the program uses the library staff and resources of Mn/DOT and CTS to extend library and information services to the state's transportation community. Any public official or consultant working for a public transportation agency in the state may contact librarians at either Mn/DOT or CTS for assistance with researching or locating transportation-related information.



The success of MTL led the National Transportation Library to support and provide funding for the Midwest Transportation Knowledge Network. The purpose of the new network was to extend the benefits of MTL to the regional level and use it to demonstrate the need for networking transportation libraries at the national level. An early product of the Midwest network was the union catalog, Transportation Libraries Catalog (TL Cat). The union catalog allows transportation practitioners anywhere around the globe to simultaneously search 20 of the nation's leading transportation libraries to locate any specific resource or find information relating to a particular topic of interest.

A particpant in:
Midwest Transportation Knowledge Network

Key to Subject Categories

Aeronautics

Bridges/ Hydraulics

Construction

Environmental

Freight

Land Manage-ment/Right of Way

Maintenance

Materials / Pavements

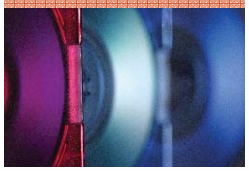
OIM/ Planning/ Policy / Finance

Tech Support / Design

Traffic/ITS

Transit

Transportation Data



Local Road Research Board

Key to Implementation Outcomes

Change with Measures:	The research resulted in change, with tangible benefits that are measured.
Change without Measures:	The research resulted in change, with tangible benefits that are not measured.
Knowledge Gained:	The research provided knowledge that is being used, but no tangible benefits have been identified or measured.
Not Usable:	The research produced results that were questionable or not useable.

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2006 List of Completed Research Projects

2006 Mn/DOT, LRRB and Pooled Fund

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List of Completed Projects

2006 Mn/DOT, LRRB and Pooled Fund

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2006-21	Contraflow Transportation Network Reconfigurations for Evacuation Route Planning	49
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2006-23	Urbanization of Minnesota's Countryside: 2000-2025: Evolving Geographics and Transportation Impacts	51
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2006-30	Feasibility Study of Portable Weight-in-Motion Systems for Highway Speed	57

Report #P2006-01

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Richard Post, Mn/DOT, Office of Maintenance

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract:
81655 WO 139

Contract Period:
8/13/2004 to 5/31/2006

Funding:
$18,060 Building Section

Program:
None

Post-Occupancy Evaluation of the Minnesota Department of Transportation St. Cloud District Headquarters Building

Description:
To identify strengths and weaknesses in the building delivery process. The expectation is that the information generated by the post occupancy evaluation will strengthen the services rendered by Facilities Management and consequently facilitate the delivery of high performance, cost effective buildings for Mn/DOT.

Conclusions:
This report documents the results of a post occupancy evaluation of Mn/DOT's St. Cloud District Headquarters which assessed building performance and client satisfaction with Facilities Management Staff.

Implementation:
N/A

Implementation Outcome:
N/A

Report located at:
Call the Mn/DOT Library at 651/296-2385.

Report #2006-01

Principal Investigator:
Lev Khazanovich, University of Minnesota

Technical Liaison:
Bernard Izevbekhai, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 133

Contract Period:
8/16/2004 to 12/31/2005

Funding:
$14,999.40 STIP
$59,007.60 Steele Dowel

Program:
2004
Pooled Fund Program

Investigation of Deterioration of Stainless Steel Dowel Tubes Under Repeated Loading

Description:
Confirm long-term bearing capacity of 316L stainless steel schedule 40 pipes that are fitted with end caps. Allow Mn/DOT and FHWA to make a rational decision on approval or rejection of this type of dowel bar as a design alternative for high performance concrete pavements. If Schedule 40 pipe is approved for use, many States may adopt Mn/DOT's specifications, as has been the case in similar dowel bar designs.

Conclusions:
Mn/DOT has selected a 316L stainless steel schedule 40 pipe as a new dowel bar to be used as a bid alternative for its high performance Portland Cement Concrete (PCC) pavements. Although this dowel bar should provide sufficient shear transfer capacity and low concrete bearing stresses, there was a concern that lack of a solid core may not provide sufficient resistance of the cross-section to distortion under a heavy axle loading. In this study, long-term performance of the 316L stainless steel schedule 40 pipe was investigated by subjecting a doweled joint to accelerated repeated loads through the use of the Minnesota Accelerated Loading Facility (Minne-ALF-2). Assessment of the new dowel bar performance was performed based on comparison with the standard 1.5 inch diameter epoxy -coated round steel dowel. The following tasks were accomplished: redesign, assembly and calibration of new version of Minne-ALF, development of experimental design matrix, conduct of accelerated full-scale testing, and post-testing evaluation. The results from the MinneALF-2 tests illustrated that while the LTE for the stainless steel dowel tubes was lower than the LTE for the epoxy-coated dowels, the stainless steel tubes are capable of providing over 70% LTE in the long-term when installed in concrete pavement joints. The ability to withstand deformation and corrosion while providing sufficient long-term performance suggests that the stainless steel tube dowel is an attractive alternative to the solid epoxy-coated dowel for use in long-life pavements.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out memo was written

Report located at:
http://www.lrrb.org/pdf/200601.pdf

Report #2006-03

Principal Investigator:
Max Donath, University of Minnesota

CoPrincipal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 142

Contract Period:
4/1/2000 to 6/30/2002

Funding:
$401,026 Pooled Fund—MnROAD

Program:
Poold Fund

Statistical Modeling for Intersection Decision Support

Description:
This project is Minnesota's piece of a federal grant program which is focused on the improvement of safety at intersections. The overall objectives of the project are to improve safety and mobility with a system that is deployable, robust, easily maintained, and cost effective. The specific Minnesota contribution is to meet these goals for rural intersections found nationwide and to develop surveillance technology and collision predictive algorithms applicable to all intersection types.

Conclusions:
This project was a component of the Intersection Decision Support (IDS) effort conducted at the University of Minnesota. In this project, statistical modeling was applied to crash data from 198 two-way, stop-controlled, intersections on Minnesota rural expressways, in order to: (1) identify intersections that were plausible candidates for future IDS deployment; (2) develop a method for estimating the crash-reduction effect of IDS deployment; (3) develop a method for predicting the crash-reduction potential of IDS deployment, and (4) test the hypothesis that older drivers were over-represented in intersection crashes along US Trunk Highway 52. All these objectives were accomplished using hierarchical model structures similar to that employed in the Interactive Highway Safety Design Model. Five rural expressway intersections were identified as having crash frequencies that were atypically high, and this group included the intersection of US Trunk Highway 52 and Goodhue County highway 9, the site chosen for the prototype IDS deployment. It was then determined that a 3-year count of crashes after deployment would probably be sufficient to detect any crash reduction effect due to the IDS, although a reliable estimate of the magnitude of this effect would require a longer test period. Assuming that the effect of an IDS deployment would be to make the crash frequencies at treated intersections similar to that experienced by typical intersections, it was estimated that deployment of the IDS at the five high-crash intersections would, over a 15-year period, result in a reduction of about 308 crashes. Finally, using an induced-exposure approach, twelve intersections were identified as showing over-representation of older drivers, five of these being on US Trunk Highway 52.

Implementation:
Project was featured in the FHWA's “Research and Technology Transporter “; October 2004 edition.
Intermediate results were presented at the Traffic Flow and Safety Council meeting on October 3, 2003.

No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200603.pdf

Relates to:
Contract 74708 WO 142 “Driver Assistive Systems for Snowplows”

Report #2006-04

Principal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
Todd Niemann, Mn/DOT, Office of Bridges

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 133

Contract Period:
11/15/1999 to 9/29/2004

Funding:
$150,000 STIP

Program:
Mn/DOT Transportation Research Program

Use of Adhesives to Retrofit Out-of-Plane Distortion Induced Fatigue Cracks

Description:
This project will develop and test an adhesively bonded retrofit for connection plates that are not attached to girder flanges.

Conclusions:
Mn/DOT has selected a 316L stainless steel schedule 40 pipe as a new dowel bar to be used as a bid alternative for its high performance Portland Cement Concrete (PCC) pavements. Although this dowel bar should provide sufficient shear transfer capacity and low concrete bearing stresses, there was a concern that lack of a solid core may not provide sufficient resistance of the cross-section to distortion under a heavy axle loading. In this study, long-term performance of the 316L stainless steel schedule 40 pipe was investigated by subjecting a doweled joint to accelerated repeated loads through the use of the Minnesota Accelerated Loading Facility (Minne-ALF-2). Assessment of the new dowel bar performance was performed based on comparison with the standard 1.5 inch diameter epoxy -coated round steel dowel. The following tasks were accomplished: redesign, assembly and calibration of new version of Minne-ALF, development of experimental design matrix, conduct of accelerated full-scale testing, and post-testing evaluation. The results from the MinneALF-2 tests illustrated that while the LTE for the stainless steel dowel tubes was lower than the LTE for the epoxy-coated dowels, the stainless steel tubes are capable of providing over 70% LTE in the long-term when installed in concrete pavement joints. The ability to withstand deformation and corrosion while providing sufficient long-term performance suggests that the stainless steel tube dowel is an attractive alternative to the solid epoxy-coated dowel for use in long-life pavements.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200604.pdf

Report #2006-05

Principal Investigator:
Jiann-Shiou Yang, University of Minnesota—Duluth

Technical Liaison:
George Cepress, Mn/DOT, Office of Transportation Data & Analysis

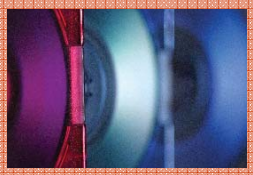
Administrative Liaison:
Nelson Cruz, Mn/DOT

Contract:
81655 WO 130

Contract Period:
7/23/2004 to 2/28/2006

Funding:
$53,044 STIP

Program:
Mn/DOT Transportation Research Program



A Nonlinear State Space Approach to Arterial Travel Time Prediction

Description:
This project will focus on arterial travel time prediction by developing a recursive, nonlinear state space model to predict short-term travel time on arterials. Prediction of travel time is potentially more challenging for arterials than for freeways because vehicles traveling on arterials are not only subject to queuing delay but also to traffic signal delay.

Conclusions:
The study uses time series and the Kalman prediction techniques along with modern technology such as the Global Positioning System (GPS) for accurate data collection and analysis. A greater understanding of travel time will help facilitate traffic system performance monitoring, control, planning, and informed route decisions for motorists accessing information from changeable message sings (CMS). The models used for estimations include the autoregressive integrated moving average (ARIMA) and the autoregressive moving average (ARMA). The study collects travel data for the peak hours of travel (3:30-5:00 p.m.) over an eight-month period on the busiest section of Highway 194 in Duluth, Minnesota. The predictions were conducted over two weeks during the summer of 2005. Observed and predicted travel times are charted carefully and report evaluations determine the success of the study.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out memo was written

Report located at:
http://www.lrrb.org/pdf/200605.pdf

Report #2006-06

Principal Investigator:
Taek Kwon, University of Minnesota—Duluth

Technical Liaison:
Jose Fischer, Mn/DOT, Traffic Management Center

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
81655 WO 40

Contract Period:
11/1/2003 to 2/28/2006

Funding:
$40,800 Guidestar
$10,200 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Section Travel-Time Measurement and Vehicle Classification Using Inductance Signatures of Loop Detectors

Description:
To study a more accurate way of measuring section travel time by tracing vehicle inductance signatures generated by loop detectors.

Conclusions:
Travel-time data provides vital information for traffic monitoring, management, and planning. The objective of this research was to develop a new computational approach to accurately measure travel time from two sets of spatially separated loop detectors using re-identification of vehicle inductance signatures generated by the loops. In order to restore lost details from the raw inductance waveforms, the author modeled the output of the loop detectors as a convolution of the original vehicle signature and the loop system function. To solve this blind problem, two basic blind deconvolution approaches were used. The first estimates the loop system function using a speed estimate obtained from the inductance waveform. The second approach is an adaptive iterative method referred to as the Godard blind deconvolution. Experimental results showed that both methods performed well and significantly exposed the original signature information with unique vehicle characteristics.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200606.pdf

Report #2006-07

Principal Investigator:
Jerome Hajjar, University of Minnesota

Technical Liaison:
Tom Marritt, Mn/DOT, Office of Bridges

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
81655 WO 59

Contract Period:
4/15/2003 to 4/28/2006

Funding:
$188,367 STIP

Program:
Mn/DOT Transportation Research Program

Fatigue-resistant Design Details for Overhead Signs, Mast-arm Sign Poles, and Lighting Standards

Description:
To experimentally address the fatigue strength of typical pole-to-arm connections and other details used in the State of Minnesota for overhead signs, mast-arm sign poles and lighting standards.

Conclusions:
Traffic signs and signals are often supported by flexible cantilevered structures that are susceptible to wind-induced vibration and fatigue. The latest version of the design specifications published by the American Association of State Transportation Officials (AASHTO) now considers fatigue as a limit state. However, most of the fatigue classifications for welded details were not based on full-scale testing, and are thought to be overly conservative. This research will address the fatigue resistance of two common mast arm-to-pole connections used in the state of Minnesota. The resistance attained experimentally aligned with current predictions using AASHTO procedures, except for in-plane loading of box connection details. As a consequence of specimen design, a variety of tube-to-transverse plate connections were also tested using multi-sided tube cross-sections with different tube diameters, tube thicknesses, as well as base plate thicknesses. The standard tube-to-transverse plate connection exhibited Category K2 resistance, two categories lower than the E specified by AASHTO. This resistance was enhanced to Category E through impact treatment or Category E by doubling the base plate thickness. Gusset plates could not prevent cracking of the tube at the base plate, but the tips of the gusset plate exhibited Category E resistance.

Implementation:
Justin Ocel presented at the 2005 Transportation Research Conference. and at the Northern State Conference in October 2005.

No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200607.pdf

Report #2006-08

Principal Investigator:
Ginney Crowson, Short Elliott Hendrickson, Inc.

Technical Liaison:
Mark Nelson, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
87789

Contract Period:
10/14/2005 to 11/30/2006

Funding:
$50,000 NW Passage—Idaho Partner
$50,000 NW Passage—Wyoming Partner
$73,379.42 Pooled Fund

Program:
2004
SP&R
TPF-5(093)

North/West Passage Transportation Pooled Fund Program - Phase I (TPF-5(093)

Description:
The purpose of this project is to develop an expanded ITS integrated Corridor Strategic Plan for the North/West Passage Corridor. Development of the ITS plan will help the state to coordinate integrated corridor efforts particularly across state borders and identify future projects to pursue within the North/West Passage Corridor. The plan will include a high level architecture for the corridor, an inventory of communication coverage and a coordinated deployment/concept of operations for traveler information.

Conclusions:
The North/West Transportation Pooled Fund Program successfully completed phase one, consisting of nine projects that incorporated methods for coordinating, developing and sharing traveler and road maintenance information across a multi-state corridor stretching from Wisconsin to Washington.

Implementation:
A Trading Card was created and disseminated. There is a Phase II to this project.

Implementation Outcome:
No Close-out memo was written because there is a Phase II.

Report located at: http://www.lrrb.org/pdf/200608.pdf

Related Project:
Contract 87789 "North/West Passage Transportation Pooled Fund Study - Phase II" (TPF-5(093)

Report #2006-09

Principal Investigator:
Kelly Strong, Iowa State University

Technical Liaison:
Tom Ravn, Mn/DOT, Mendota Resident Office

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
82617 WO 7

Contract Period:
9/9/2004 to 3/31/2006

Funding:
$86,203 STIP

Program:
Mn/DOT Transportation Research Program

Performance Effectiveness of Design-Build, Lane Rental, and A + B Contracting Techniques

Description:
The purpose of this research project is to investigate the effectiveness of using alternative contracting techniques for transportation projects. Specifically, the objectives are to compare performance, cost and value implications of design-build contracts, A+B contracts, and lane rental contracts. Specific performance measures will be determined after a thorough literature review, consultation with Dr. Molenaar, and meetings with Mn/DOT managers and engineers. However, prior research in this area, along with Table 5-1 "Performance Framework and Measures" from the Minnesota Statewide Transportation Plan suggest that at a minimum, first cost, cost variation, schedule, safety, project quality, overall value, and administrative expenditures should be considered. The proposed research will also identify critical success factors required to maximize the effectiveness of each contracting techniques and compare the three alternative contracting techniques to traditional contracting on relevant performance factors.

Conclusions:
Experimentation with innovative contracting methods over the last several years has produced several techniques recently formally approved for use by the Federal Highway Administration. While the FHWA has recognized and defined many standard practices for innovative contracting, the need has arisen to compare the effectiveness of different innovative contracting methods to each other. Performance and cost and value implications of A+B contracts, design-build contracts, lane rental contracts, and traditional contracts were investigated. Specific performance and cost measures considered are Administration Costs, Project Costs, Management Complexity, Disruption to Third Parties, RUC, Innovation, Product/Process Quality, and Funding Flexibility. Performance parameters are compared on nine different project types; the methodology utilized a survey of national experts who rated each innovative contracting method for each performance factor on each of the project types. This study resulted in fifteen recommendations for improving management practices in the use of innovative contracting for transportation projects. These recommendations are also intended to assist Mn/DOT in determining which contract method is likely to be most effective given certain project criteria and construction options and to determine directions for future research, particularly on emerging methods such as design-sequencing and A + B + C contracting.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report located at: http://www.lrrb.org/pdf/200609.pdf

Report #2006-10

Principal Investigator:
Max Donath, University of Minnesota

CoPrincipal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
Ray Starr, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 106

Contract Period:
1/2/2004 to 12/31/2008

Funding:
$498,500 Pooled Fund

Program:
Pooled Fund TPF-5(086)

Review of Wisconsin's Rural Intersection Crashes: Application of Methodology for Indentifying Intersections for Intersection Decision Support (IDS)

Description:
Multi-state pooled fund study to gain a national basis for deployment of its Intersection Decision Support (IDS) Project. Plan has 3 facets: 1) a review of state intersection crashes for each participating state, 2) participation in the process to design and refine candidate intersection Driver/Infrastructure Interfaces, and 3) instrumentation of candidate intersections to acquire data regarding the behavior of drivers at rural intersections over a wide geographical base.

Conclusions:
The IDS research project is sponsored by a consortium of states (Minnesota, California, and Virginia) and the Federal Highway Administration (FHWA) whose objective is to improve intersection safety. The Minnesota team's focus is to develop a better understanding of the causes of crashes at rural unsignalized intersections and then develop a technology solution to address the cause(s). In the original study, a review of Minnesota's rural crash records and of past research identified poor driver gap selection as a major contributing cause of rural intersection crashes. Consequently, the design of the rural IDS technology has focused on enhancing the driver's ability to successfully negotiate rural intersections by communicating information about the available gaps in the traffic stream to the driver. In order to develop an IDS technology that has the potential to be nationally deployed, the regional differences at rural intersections must first be understood. Only then can a universal solution be designed and evaluated. To achieve this goal of national consensus and deployment, the University of Minnesota and Mn/DOT initiated a State Pooled Fund study, in which nine states are cooperating in intersection-crash research. This report documents the crash analysis phase of the pooled fund study for the State of Wisconsin.

Implementation:
No Implementation database

Implementation Outcome:
No Implementation database

Report located at: http://www.lrrb.org/pdf/200610.pdf

Report #2006-11

Principal Investigator:
Jonathan Chaplin, University of Minnesota

Technical Liaison:
Bob Wyrk, Mn/DOT, Hwy Maintenance Superintendent

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract:
81655 WO 151

Contract Period:
1/17/2005 to 8/31/2006

Funding:
$40,000 Maintenance Research

Program:
Maintenance

Development of a Trash Harvester for Mn/DOT - Phase 1

Description:
The objective of Phase 1 of this research is to develop design specifications for a trash harvester, to select a concept using the decision matrix approach, and finally to develop a detailed engineering design that will be used to build a machine prototype for testing.

Conclusions:
The Trash Harvester Project reports on the design of a vehicle, capable of collecting litter on grass, for clean up of trash along Minnesota highways.

Implementation:
There is a phase II project titled "Development of a Trash Harvester for Mn/DOT—Phase 2" Contract 81655 WO 174

Implementation Outcome:
No Close-out memo was written

Report located at: HOLDING PUBLICATION FOR POSSIBLE PATENT

Related Project:
"Development of a Trash Harvester for Mn/DOT—Phase 2" Contract 81655 WO 174

Report #2006-12

Principal Investigator:
Rebecca Embacher, Formerly– Office of Materials

Technical Liaison:
Dave Rholl, Winona County

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
None Contract (2000-023P)

Contract Period:
N/A

Funding:
$$51,000 LRRB

Program:
CY2000 LRRB INV 754

Duration of Spring-Thaw Recovery for Aggregate-Surfaced Roads

Description:
This study utilized dynamic cone penetrometer to evaluate the effectiveness of spring load restrictions on low-volume roads.

Conclusions:
Low-volume roads constructed in regions susceptible to freezing and thawing periods are often at risk of load-related damage during the spring-thaw period. The reduced support capacity during the thawing period is a result of excess melt water that becomes trapped above the underlying frozen layers. Many agencies place spring load restrictions (SLR) during the thaw period to reduce unnecessary damage to the roadways. The period of SLR set forth by Mn/DOT is effective for all flexible pavements; however, experience suggests that many aggregate-surfaced roads require additional time relative to flexible pavements to recover strength sufficient to carry unrestricted loads. An investigation was performed to improve local agencies' ability to evaluate the duration of SLR on aggregate-surfaced roadways. This was accomplished through seasonal measurements of in-situ shear strengths, measured using the dynamic cone penetrometer (DCP), on various Minnesota county routes. In-situ strength tests were conducted on selected county gravel roads over the course of three years. Strength levels recorded during the spring-thaw weakened period were compared to fully recovered periods that typically occur in late spring/summer. The results indicate that aggregate-surfaced roads generally require 1 to 3 additional weeks, over that of flexible pavements, to reach recovered bearing capacity. Additionally, a strong correlation was found between duration required to attain given strength recovery values and climatic and grading inputs.

Implementation:
Article published in “TR News” November-December 2000 issue "Spring Load Restrictions; Improving Minnesota's Policy".

No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200612.pdf

Report #2006-13

Principal Investigator:
CNA Consulting Engineers Incorporated

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
87803

Contract Period:
4/22/2005 to 6/30/2006

Funding:
$24,938.55 STIP

Program:
Mn/DOT Transportation Research Program

Intelligent Compaction and In-Situ Testing at Mn/DOT TH53

Description:
Perform field testing and provide a report that documents the field demonstrations and validation of the wireless Light-Weight Deflectometer.

Conclusions:
This report describes an intelligent compaction demonstration project on Mn/DOT TH 53 in Duluth, MN, and the associated field and laboratory testing. The project was conducted during September 2005, using a Caterpillar Model CS-563E vibratory soil compactor, equipped with Intelligent Compaction (both Compaction Meter Value (CMV) and energy or power) and global positioning system (GPS) technology. A Prima light-weight deflectometer (LWD), dynamic cone penetrometer (DCP) and Humboldt GeoGauge were used to collect in situ companion test data at 42 locations. Mn/DOT conducted gradation, moisture content and Procter tests. Location and Compaction Meter Value (CMV) were downloaded for comparison with the in situ testing. CMV data was compared to the in situ data on a point-by-point basis and on the basis of the overall distribution. In general, poor correlations were obtained on a point-by-point basis, likely due to the depth and stress dependency of soil modulus, and the heterogeneity of the soils. Good correlations were obtained between CMV values and DCP measurements for depths between 8-inches and 16-inches deep. The Caterpillar Compaction Viewer software, although still in development at the time of testing, is functional and is well integrated with GPS. It is easy to extract data and do more sophisticated analyses. Surface-covering documentation adds value by identifying potential problem areas where compaction is limited by material, moisture or subgrade deficiencies. LWD testing protocol must be followed to obtain useful results, since measurements vary significantly between successive tests. Relatively good correlations were obtained between LWD and GeoGauge. The GPS technology used for the demonstration is not adequate to distinguish between lifts.

Implementation:
Implementation Plan was received.

Implementation Outcome:
No Close-out Memo was written.

Report located at: http://www.lrrb.org/pdf/200613.pdf

Report #2006-14

Principal Investigator:
Panos Michalopoulos, University of Minnesota

Technical Liaison:
Jim McCarthy, FHWA

Administrative Liaison:
Cory Johnson, Mn/DOT

Contract:
81655 WO 94

Contract Period:
4/22/2004 to 6/30/2006

Funding:
$124,800 Guidestar
$31,200 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Streamlining of the Traffic Modeling Process for Implementation in the Twin Cities Freeway Network - Phase IIa

Description:
The objective of this project is to streamline the simulation process. This streamlining is part of a continuous effort aiming in making employment of microscopic simulation practical, user friendly, and as efficient as possible.

Conclusions:
Comprehensive methodologies are proposed for improving the quality of both freeway and arterial intersections traffic volumes for the purpose of enabling and improving traffic simulations. Specifically, established and enhanced procedures for checking and correcting freeway temporal errors are integrated with an optimization-based algorithm for reconciling spatial inconsistencies in freeway traffic counts. In addition to this, an empirical methodology is further integrated to balance arterial intersection traffic counts. The proposed methodologies have been successfully automated and implemented as two computer programs, i.e., TradaX for processing freeway volume and ArtBaT for arterial intersection traffic counts. Initial evaluations of these tools suggest that they have the potential of reducing total modeling time by 25% ~ 30%, while resulting in improved calibration of simulation models, more reliable analysis, and better use of staff resources for meeting project deadlines.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out memo was written.

Report located at: http://www.lrrb.org/pdf/2006.pdf

Relates to:
Contract 74708 WO 164 "Employment of the Traffic Management Laboratory (TRAMLAB) for Evaluating Ramp Control Strategies - Phase I"
Contract 81655 WO 95 "The Value of Traveler Information for Motorists"
Contract 81655 WO 96 "Evaluation and Improvement of the Stratified Ramp Metering algorithm through microscopic simulation - Phase IIb"
Contract 81655 WO 176 "Employment of the Traffic Management Lab for the Evaluation and Improvement of Stratified Metering Algorithm: Phase III"
Contract 81655 WO 252 "Employment of Traffic Management Laboratory for the Evaluation & Improvement of Stratified Metering Algorithm: Phase IV"
IMP 2003-03 "TRAMLAB Software, Training, and Support"

Report #2006-15

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Technical Liaison:
Jim McGraw, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 108

Contract Period:
1/2/2004 to 5/31/2006

Funding:
$60,914 LRRB

Program:
CY2003 LRRB INV 804

Investigation of the Low-Temperature Fracture Properties of Three MnROAD Asphalt Mixtures

Description:
To determine the low temperature fracture properties of three Superpave mixtures used at MnROAD and to evaluate the effect of aging and the relation between the asphalt mixture and the asphalt binder fracture properties.

Conclusions:
In this research effort, field cores were taken from cells 33, 34 and 35 at the MnROAD facility to determine the fracture properties of the field mixtures, to compare them with the laboratory-prepared mixtures analyzed in a previous study, and to evaluate the effect of aging at different depths in the asphalt layer. In addition, the properties of the recovered binders from the field cores as well as the properties of the original binders aged in laboratory conditions were investigated. The test results and the analyses performed indicate that the fracture tests performed on asphalt binders and asphalt mixtures have the potential to predict the field performance of asphalt pavements with respect to thermal cracking. The binder results confirm the predictions of the current performance grading system; however, it appears that the fracture resistance of the PG-34 asphalt mixture is better than the fracture resistance of the PG-40 mixtures, which is the opposite of what the PG system predicts.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out memo was written

Report located at: http://www.lrrb.org/pdf/200615.pdf

Report #2006-16

Principal Investigator:
David Levinson, University of Minnesota

Technical Liaison:
Deanna Belden, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 150

Contract Period:
12/27/2004 to 5/31/2006

Funding:
$55,000 COPTRS

Program:
2004 Access to Destinations

Access to Destination: Development of Accessibility Measures

Description:
To develop a set of possible performance measurements that can be used to analyze variable sets of historic land use and travel time data, including data from the freeway networks, surface streets, transit systems, and non-motorized travel to understand accessibility---the relative ability to reach destinations on a transportation network.

Conclusions:
Transportation systems are designed to help people participate in activities distributed over space and time. Accessibility indicates the collective performance of land use and transportation systems and determines how well that complex system serves its residents. This research project comprises three main tasks. The first task reviews the literature on accessibility and its performance measures with an emphasis on measures that planners and decision makers can understand and replicate. The second task identifies the appropriate measures of accessibility, where accessibility measures are evaluated in terms of ease of understanding, accuracy and complexity, while the third task illustrates these accessibility measures. During this process a new accessibility measure named "Place Rank" is introduced as an accurate measure of accessibility. In addition, several previously-defined accessibility measures are reviewed and demonstrated in this report including Cumulative opportunity and gravity-based measures. The gravity-based measure is widely used in the literature yet cumulative opportunity tends to be easier to understand and interpret by the public, planners, and administrators. A major contribution of this research is the comparison of accessibility measures over time and among various modes. Effects of accessibility on home sales are also tested. Homebuyers pay a premium to live near jobs and away from competing workers. Accessibility promises to be a useful tool for monitoring the land use and transportation system, and assessing and valuing the benefits of proposed changes to either land use or networks.

Implementation:

Implementation Outcome:

Report located at: http://www.lrrb.org/pdf/200616.pdf

Report #2006-17

Principal Investigator:
Thomas Stinson, University of Minnesota

CoPrincipal Investigator:
Barry Ryan, University of Minnesota

Technical Liaison:
Julie Skallman, Mn/DOT, State Aid for Local Transportation Division

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 118

Contract Period:
8/6/2004 to 7/31/2006

Funding:
$86,161 State Aid

INV 814 (LRRB withdrew funds)

Program:
State Aid

Local Road Tax Options: Is Minnesota Really That Different?

Description:
The purpose of this study is to isolate the local government response to changes in the state general-purpose aids with respect to local road services. The study will address how local governments are managing state aid reductions and whether their response might cost taxpayers more over the network lifecycle than is being saved in the current funding environment. The contemporaneous nature of the aid cuts and road-funding decisions make a definite assessment difficult, however, this study will improve the understanding of how local governments are responding and highlight the area of potential concern.

Conclusions:
Local governments in the U.S. use a variety of tax mechanisms to fund local roads. Twelve options are examined in this report related to property access, vehicle use or local economic activity. The most frequent local levies are property taxes, special assessments, vehicle registration taxes, motor fuel taxes and local sales taxes. The overall mix of local road funding also varies widely by state and region. Nebraska, Wisconsin and Kansas have local road revenues most like Minnesota, while local roads funding in New Hampshire, Florida and Nevada is the least similar. The benefits of any individual road tax must be judged in the context of the larger state and local tax system.

Implementation:
Barry Ryan to present project findings at the City and County Engineers Meetings in February, 2005.

No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written

Report located at: http://www.lrrb.org/pdf/200617.pdf

Report #2006-18

Principal Investigator:
Tom Burnham, Office of Materials

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
No Contract

Contract Period:
N/A

Funding:
N/A

Program:
Work preformed at MnROAD

Construction Report for MnROAD Thin Whitetopping Test Cells 60-63

Description:
This report describes the MnROAD whitetopping test cells 60-63 by their physical characteristics and summarizes the results from material test and curl and warp measurements taken during their construction.

Conclusions:
After seven years of heavy traffic and weathering, three ultra-thin whitetopping test cells on the interstate portion of the Minnesota Road Research project (MnROAD) had reached terminal serviceability. Those three test cells were replaced by four new thin-whitetopping test cells in October 2004. This report describes the physical characteristics of the new whitetopping test cells 60-63. The report also summarizes the results from the material tests and curl and warp measurements taken during, and immediately following, construction of the test cells.

Implementation:
N/A

Implementation Outcome:
N/A

Report located at: http://www.lrrb.org/pdf/200618.pdf

Report #2006-19

Principal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
John Tarnowski, Mn/DOT, Office of Maintenance

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
81655 WO 115

Contract Period:
2/17/2004 to 8/31/2006

Funding:
$10,316 Maintenance

Program:
Maintenance

Quick Edge: Rapid Underbody Plow Cutting Edge Changing System

Description:
Look at an alternative system to the current bolting process. The new system will be designed with the objective of reducing time and manpower required in the change and decreasing the risk of injury as compared to the current labor intensive bolting process. An alternative system will be analyzed, designed, manufactured, tested, and evaluated.

Conclusions:
Much of the benefit of an underbody scraper lies in the ability to apply high levels of pressure to break up compacted ice and snow. However, this also leads to increased wear on the underbody's cutting edges and frequent replacement. This process is time and labor intensive and can often lead to a wide variety of injuries. Accordingly, the Quick Edge Rapid Underbody Cutting Edge Changing System was designed to simplify this difficult process and remove some of the risk involved. This report outlines the steps taken in creating the final working design and prototype.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: Report publication is on hold for possible patent

Report #2006-20

Principal Investigator:
John Siekmeier, Mn/DOT, Office of Materials

Technical Liaison:
Larry Berkland, Steel County

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
No Contract

Workplan Period:
8/15/2005 to 8/31/2006

Funding:
$32,700 LRRB

Program:
CY2005 LRRB INV 829

Validation of DCP and LWD Moisture Specifications for Granular Materials

Description:
There is currently no accepted protocol to measure the in situ stiffness, strength, and mositure during construction and then relate these measured values to the seasonal values that are estimated and used during mechanistic-empirical pavement design. The proposed project will result in a laboratory validation that quantifies the effects of moisture, density and grading on the dynamic cone penetrometer (DCP) strength and LWD stiffness of granular materials. The DCP and LWD precision will also be quantified under well-controlled laboratory conditions.

Conclusions:
Advances in technology have produced a new generation of in situ soil testing devices. Implementation of quality assurance procedures that make use of these devices would improve test precision, increase inspector efficiency and safety, and allow for the direct verification of values used in mechanistic design procedures. During this study, the DCP and light weight deflectometer (LWD) were used on laboratory prepared specimens. It was found that the Mn/DOT DCP specification accurately assessed compaction quality, although there were some suggestions for improvement. This study reached the following conclusions and recommendations. The DCP penetration should continue until the cone passes through the subbase lift of interest. The DCP seating requirement serves little purpose for a subbase lift that will be covered by subsequent lifts. The acceptable range of moisture contents during DCP testing of granular subbase should be capped at 10%. A sufficient amount of data exists to create an LWD trial specification for granular subbase. A mass of 10 kg, drop height of 50 cm, and plate diameter of 20 cm are recommended. It is also recommended that the LWD specification include three seating drops followed by three data drops at each new height.

Implementation:
Implementation Plan was written.

Noted on February 23, 2006: District 8 has adopted a Modified DCP spec 5-692-255. District 8 participated in the field testing during the summer of 2004/2005 on a section of TH 212. They are delivering a new project on TH 212 during the 06 season that incorporated the modified spec, they are also wondering why it is not in the specs for a 2007 TH 7 project.

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200620.pdf

Related Project: "Improvement and Development of Mn/DOT DCP Specifications for Aggregate Base and Select Granular Materials" INV 794

Report #2006-21

Principal Investigator:
Shashi Shekhar, University of Minnesota

Technical Liaison:
Sonja Morphew, Mn/DOT, Office of Homeland Security

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 97

Contract Period:
6/30/2004 to 6/30/2006

Funding:
$55,000 Guidestar

Program:
ITS

Contraflow Transportation Network Reconfiguration for Evacuation Route Planning

Description:
This project will develop algorithms and software to find the optimal logical configuration of the transportation network, given the physical network and traffic demand for an evacuation scenario. The developed software will facilitate testing of the proposed algorithm by feeding its output (logical network configuration) to an assignment-simulation tool (e.g. DYNASMART) for a set of evacuation scenarios.

Conclusions:
Given a transportation network having source nodes with evacuees and destination nodes, we want to find a contraflow network configuration, i.e., ideal direction for each edge, to minimize evacuation time. Contraflow is considered a potential remedy to reduce congestion during evacuations in the context of homeland security and natural disasters (e.g., hurricanes). This problem is computationally challenging because of the very large search space and the expensive calculation of evacuation time on a given network. To our knowledge, this paper presents the first macroscopic approaches for the solution of contraflow network reconfiguration incorporating road capacity constraints, multiple sources, congestion factor, and scalability. We formally define the contraflow problem based on graph theory and provide a framework of computational structure to classify our approaches. A Greedy heuristic is designed to produce high quality solutions with significant performance. A Bottleneck Relief heuristic is developed to deal with large numbers of evacuees. We evaluate the proposed approaches both analytically and experimentally using real world datasets. Experimental results show that our contraflow approaches can reduce evacuation time by 40% or more.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200621.pdf

Report #2006-22

Principal Investigator:
Taek Kwon,
University of Minnesota—Duluth

Technical Liaison:
Roberta Dwyer,
Mn/DOT, District 1

Administrative Liaison:
Jim Klessig,
Mn/DOT

Contract:
81655 WO 142

Contract Period:
2/1/2005 to 6/30/2006

Funding:
$7,991.20 Guidestar
$1,997.80 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Development of Efficient Integrated Data Archival/ Retrieval Model for R/WIS, RTMS, and Loop Traffic Data (Phase II)

Description:
The objective of this project is to expand the present next generation Road Weather Information System (R/WIS) to include traffic detection data such as presence, volume, occupancy and speed using non-intrusive traffic sensors, i.e., Remote Traffic Monitoring Sensor (RTMS). Since the next generation R/WIS is built around one or more Sequential Query language (SQL) database servers, a new traffic database will be designed and integrated with the present R/WIS database

Conclusions:
This report describes a new data warehouse model developed for integrating R/WIS and traffic data and the prototype implemented. The building blocks of the prototype include data aggregation methods from sensors, a data archiving system, and multi-user data access and retrieval environments through a network. This new data warehouse model seamlessly integrates the heterogeneous nature of R/WIS and traffic data. The key to this data model was utilization of a network storage model referred to as a parallel First-In-First-Out (FIFO) data storage where various sensor data are deposited as they are aggregated while different types of data-consuming modules obtain data without an explicit protocol requirement. For the prototype implementation, four different data aggregation methods from traffic and R/WIS sources were used to demonstrate that diverse data types and collection methods could be seamlessly integrated together. As an application of this data warehouse, weather impact on traffic flow was studied by retrieving traffic data under various atmospheric and pavement conditions, and the results are included. It was noticed that R/WIS provides a significant advantage over the traditional National Weather Service data in learning detailed location specific weather and pavement conditions from which weather impact on traffic flow could be accurately analyzed.

Implementation:
No Implementation Database

Implementation Outcome:
No Implementation Database

Report located at: http://www.lrrb.org/pdf/2006.pdf

Related Project:
"Integration of RTMS and SQL Server to Mn/DOT Next Generation R/WIS"
Contract 74708 WO 101

Report #2006-23

Principal Investigator:
John Adams, University of Minnesota

Technical Liaison:
Deanna Belden and Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 105

Contract Period:
12/5/2003 to 6/30/2006

Funding:
$98,277 COPTRS
$40,000 LRRB

Program:
CY2003 LRRB INV 797 and Mn/DOT Transportation Research Program

Urbanization of MN's Countryside: 2000-2025 - Future Geographics and Transportation Impacts

Description:
The principal objective of the study is to interpret aggregate data for counties and minor civil divisions and public use microdata samples for households and individuals to create up-to-date profiles of three types of change for the period 1990-2000 for 20 to 25 representative Minnesota regional centers and their adjacent commuting fields. A second objective is to interpret those changes with respect to their implications for long range highway transportation planning, land use, and environmental issues.

Conclusions:
In this study, we examine population and housing change, changes in industrial activity and occupational changes, and characteristics of commuters and the journey to work for those working away from home in 26 regional centers and their commute sheds in Greater Minnesota. We also explore ways in which Public Use Microdata Samples (PUMS) and Public Use Microdata Areas (PUMAs) might be exploited to shed additional insight into the changing nature of the demographic, economic and commuting patterns that are now pervasive throughout Greater Minnesota. These data are evaluated to explore links between demographic and economic features of working-age populations, and relationships between worker and household characteristics and aspects of commuting activity on the other. The final chapter examines regional economic vitality and travel behavior across the Minnesota Countryside. When population change in sample regional centers in the 1990s is compared with change in the nearby counties that comprise the centers' commuting fields, four situations appear: those where centers and their commuting fields both had population increases; centers with declining populations, but increases in the commuting fields; centers with growing populations, but with declines in their commuting fields; and situations where both the center and the commute field lost population.

Implementation:
John Adams presented the findings at the Economy Research Council meeting on November 10, 2005 at the University of Minnesota.

No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report located at: http://www.lrrb.org/pdf/2006.pdf

Report #2006-25

Principal Investigator:
David Noyce, University of Wisconsin—Madison

Technical Liaison:
Loren Hill, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
86100

Contract Period:
5/5/2004 to 6/30/2006

Funding:
$25,728 LRRB
$25,728 STIP

Program:
CY2003LRRB
INV791

Safety and Operational Characteristics of Two-Way Left-Turn Lanes

Description:
This research will compare crash rates and operational characteristics, using before and after procedures, to determine if roadways constructed with two-way left-turn lanes (TWLTLs) are safer or operationally more efficient compared to four-lane divided or four-lane undivided roadways. A detailed review of experiences in other states will also be presented including factors related to capacity, limitations on their applicability, operating speeds, access control and accommodation of non-motorized roadway users.

Conclusions:
The purpose of this research was to evaluate the safety and operational characteristics of TWLTLs compared to four-lane undivided roadways in Minnesota. Research tasks to achieve this purpose consisted of a comprehensive literature review, data collection from the identified study sites, and statistical data analysis. Nine study sites were selected, located throughout the state of Minnesota. Operational and crash data were analyzed before and after the conversion from a four-lane undivided roadway to a three-lane roadway with a TWLTL. The results of a yoked/ group comparison analysis showed statistically significant reductions in total crashes, PDO crashes and left turn crashes. The percentage reductions in total crashes, PDO crashes and left turn crashes after the conversion were approximately 37 percent, 46 percent and 24 percent, respectively. The reductions in crash rates for total crashes and PDO crashes were found statistically significant and the percentage reductions were 46 percent and 45 percent, respectively. Additionally, the change in the mean speed and 85th percentile speed were found statistically significant, but in both cases the change was less than two miles per hour. The results of this research show that safety characteristics of a roadway are improved when a four-lane undivided roadway is converted to a three-lane roadway with a TWLTL when daily traffic volumes are less than 17,500 vehicles per day.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200625.pdf

Report #2006-26

Principal Investigator:
Bojan Guzina, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract:
81655 WO 57

Contract Period:
11/1/2002 to 6/30/2006

Funding:
$197,937 STIP

Program:
Mn/DOT Transportation Research Program

Moisture Effects on PVD and DCP Measurements

Description:
To elevate the quality assurance practices and field testing of unpaved subgrade and granular base profiles, the proposed project will focus on the development of a laboratory procedure for understanding and quantifying the effects of moisture on the soil's stiffness and strength characteristics and relating the laboratory measurements to field estimates of the associated soil parameters.

Conclusions:
This study deals with the experimental investigation of the effects of moisture and density on the elastic moduli and strength of four subgrade soils generally representing the range of road conditions in Minnesota. The testing approach involved i) reduced-scale simulation of field compaction, ii) field-type testing on prismatic soil volumes, and iii) element testing on cylindrical soil specimens. The field-type testing included: i) the GeoGauge, ii) the PRIMA 100 device, iii) the modified light weight deflectometer (LWD) device, iv) the portable vibratory deflectometer (PVD) and v) the Dynamic Cone Penetrometer (DCP). To compare the Young's modulus values stemming from the field-type and laboratory experiments, cylindrical specimens were extracted from the prismatic soil volumes and tested for the resilient modulus (Mr.), small-strain Young's modulus using bender elements. The results reveal that both moisture and density have a measurable effect on the elastic modulus and strength of all four soils. On the element testing side, the small strain estimates from the bender element tests were in good agreement with the resilient modulus values. In the context of field testing, there was significant scatter of the estimated Young's moduli depending upon the particular testing device.

Implementation:
Professor Guzina presented this project on August 5, 2002 at the Maplewood Lab at the "Unsaturated Soil Engineering: Applications in Pavements" Seminar. It was titled "Mositure Effects on DCP and Portable Vibratory Deflectometer (PVD) Measurements". It is on-line at: http://mnroad.dot.state.mn.us/research/MnROAD Project/m-e group/UnsaturatedSoil seminar.asp

No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200626.pdf

Related Projects:
"Enhanced Portable Device for Subgrade and Granular Base Characterization" Contract 74708 WO 185
"Resilient Modulus Testing Following LTPP P-46 Protocol" Contract 81655 WO 32
"Moisture Effects on DCP and PFWD Measurements - Phase I " (CTS FUNDED)

Report #2006-27

Principal Investigator:
Bruce Wilson, University of Minnesota

Technical Liaison:
Brett Troyer, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
81655 WO 61

Contract Period:
2/4/2003 to 7/30/2006

Funding:
$50,000 STIP
$50,000 LRRB

Program:
CY2002 LRRB INV 787 and Mn/DOT Transportation Research Program

Risk Assessment Tool for Selection of Erosion Control Practices

Description:
Develop a theoretical framework for the design of effective erosion control strategies for construction sites.

Conclusions:
The impact of erosion and sediment from construction sites can be reduced by using a variety of onsite and offsite practices. The WATER model was developed to be a tool to assess the effectiveness of different sediment control practices. The WATER model evaluates risk by performing many simulations of a construction site response for different weather conditions. A particularly important component of the WATER model is the prediction of daily climate variables and storm characteristics called WINDS. This model uses the statistics for the analyzed data to predict many years of possible weather conditions. Predicted weather and storm characteristics are in very good agreement with those observed. The WATER model simulates surface runoff, plant processes, and erosion and sediment transport as major hillslope processes. Four runoff events (spring dry run, spring wet run, fall dry run, and fall wet run) from artificial rainfall conditions were measured.

Implementation:
Bruce Wilson presented "Risk Assessment Tools for Controlling Sediment from Construction Sites" at the Minnesota Erosion Control Association Conference in March 2006.

No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200627.pdf

Report #2006-28

Principal Investigator:
Paul Bloom, University of Minnesota

Technical Liaison:
Robert Edstrom, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 88

Contract Period:
10/15/2003 to 7/30/2006

Funding:
$98,000 STIP

Program:
Mn/DOT Transportation Research Program

Chemical Inventory and Database Development for Recycled Material Substitutes

Description:
To produce chemical data on wastes, non-surface background soils and natural aggregates for use in a hazard assessment due-diligence screening tool. In addition, sampling and laboratory protocols will be developed for site and waste specific analyses.

Conclusions:
Mn/DOT engineers are increasingly looking to recycled materials as readily available and cost-effective substitutes for natural aggregate and to fly ash as a material that can be used in the stabilization of sub-base soils. These recycled wastes have the potential to contain unacceptably high levels of some chemicals. This project produced chemical data on wastes, non-surface background soils, and natural aggregates for use in a due diligence screening tool in current service by Mn/DOT and developed by the Office of Environmental Services (OES). These data will be used by OES for their internal Mn/DOT due diligence determinations using their streamlined hazard evaluation process. A future Local Road Research Board project will transform the OES streamlined hazard evaluation process into a CD-based product for use by the larger transportation community. Data developed by this current project will be used to populate the future CD-based product electronic database. This project will maintain consistency with the current in use Office of Environmental Services (OES) streamlined hazard evaluation process for waste recycling in Mn/DOT infrastructure projects.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200628.pdf

Report #2006-29

Principal Investigator:
Albert Yonas, University of Minnesota

Technical Liaison:
Linda Taylor, Mn/DOT, Office of Maintenance

Administrative Liaison:
Nelson Cruz, Mn/DOT

Contract:
81655 WO 143

Contract Period:
9/24/2004 to 7/31/2006

Funding:
$31,000 Maintenance

Program:
Maintenance

Improving the Ability of Drivers to Avoid Collisions With Snowplows in Fog and Snow

Description:
To optimize the design of vehicles such as snowplows so that drivers who follow them will be able to perceive that they are going to crash into them if they don't slow down. The color of the snowplow, the flashing and arrangement of lighting will be investigated to find what combination of spatial, temporal and chromatic conditions make it easiest for the visual system to detect motion carried information for impending collision.

Conclusions:
The goal of this work is to understand how the processing of motion under the conditions created by blowing snow causes drivers to fail to detect that they are approaching a vehicle ahead. Color was examined under blowing snow conditions to assess whether an equiluminant (equal brightness) situation was created. In this situation, contrast in light level is not detected but differences in color are. When an equilument situation is created by snow, a perceptual illusion lowers the ability to perceive approach. The results indicate that colors in the red-yellow part of the spectrum can create a dangerous equiluminant situation in blowing snow and fog. We were unable to find an optimum color to paint snowplows to make them less susceptible to rear-end collisions. Perception studies investigated the ability of the visual system to detect the expansion pattern that drivers use to perceive that they are approaching a vehicle. We found that low contrast created by a snow cloud greatly reduces the ability to perceive approach. Flashing lights that increase conspicuity, substantially decreased the chances that a driver will be able to avoid a crash. Additional ways to improve the placement of warning lights based on these findings were proposed.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200629.pdf

Report #2006-30

Principal Investigator:
Kenneth Miller, St. Cloud State University

Technical Liaison:
George Cepress, Mn/DOT, Office of Transportation Data and Analysis

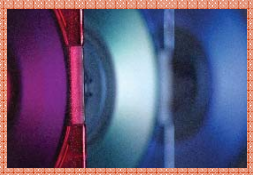
Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
88227

Contract Period:
8/1/2005 to 8/31/2006

Funding:
$13,588 STIP

Program:
Mn/DOT Transportation Research Program



Feasibility Study of Portable Weight-in-Motion Systems for Highway Speed

Description:
The purpose of this project is the provide specifications for portable weigh-in-motion systems and identify acceptable suppliers. The projects will study WIM information in 3 areas, studies in other states, update on previous work and visiting existing WIM portable WIM systems. The required systems must be capable of monitoring traffic at highway speeds with little or no permanent modification to the road. At the end of this project, Mn/DOT will have a set of purchasing specifications and test data on candidate systems.

Conclusions:
Minnesota Department of Transportation (Mn/DOT) needs improved traffic monitoring tools to optimally allocate road maintenance and improvement resources. In particular, the department needs a method of including vehicle and axle weights with portable traffic logging equipment. The cost of existing Weigh-in-Motion (WIM) equipment prevents widespread use in locations where only temporary monitoring is needed. This project was a survey of the suppliers of portable WIM systems, allowing a few systems to be moved between locations of interest. There were four candidate systems found and studied, of which two are recommended for further evaluation. Both systems appear to meet the needs Mn/DOT established and local testing will allow a final decision on their suitability.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out Memo was written

Report located at: http://www.lrrb.org/pdf/200630.pdf

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Report #2005-01

Principal Investigator:
Jim Grothaus, CTS, University of Minnesota

Technical Liaison:
Wendy Frederickson, Mn/DOT

Kathy Schaefer, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 110

Contract Period:
January 2, 2004 to September 30, 2005

Funding:
$28,000 Maintenance Research
$24,000 LRRB

Program:
Cy2003 LRRB and Maintenance

Minnesota Snow and Ice Control Field Handbook

Description:
The purpose of this field handbook is to help promote the understanding of the tools, best practices, and limitations for snow and ice control.

Conclusions:
This laminated field guide brings the latest technology to the snow plow operators. It was designed to be used as a training tool and as a reference guide in the trucks. It provides state of the art information on how to keep roads safe and reduce environmental impacts. Major topics covered are planning for winter operations, anti-icing, pre-wetting/pre-treating, standard best practices and quality control.

Implementation:
Magazine titled "Government Engineering" is writing a series of 4 articles from May through December 2006 using this manual.

Kathleen Schaefer &Wendy Frederickson gave a preview of manual at the Maintenance Expo 2005.

Implementation Outcome:
No close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200501.pdf

Report #2005-02

Principal Investigator:
Gene Skok, University of Minnesota

Co-Principal Investigator:
Mihai Marasteanu, University of Minnesota

Technical Liaisons:
Jim McGraw, Mn/DOT, Office of Materials

Richard Larson, Mille Lacs County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
81655 WO 51

Contract Period:
12/1/2002
to 12/30/2004

Funding:
$51,452
LRRB

Program:
CY2003 LRRB
INV 788

Recycled Asphalt Pavement (RAP) Effects on Binder and Mixture Quality

Description:
It is an important priority to study and determine the effects various types and percentages of RAP have on the asphalt cement and mixture quality.

Conclusions:
Based on the analysis performed on the experimental data obtained in this study the following recommendations are made:

- Extend the asphalt mixture testing to investigate the performance of RAP mixtures under repeated loading cycles, such as repeated creep and fatigue tests
- Perform moisture susceptibility tests at lower temperatures, such as 10ºC
- Extend the asphalt binder testing to include low temperature direct tension (and calculate MP1a critical temperature), repeated creep and strain sweeps at high and low temperatures.

It is also recommended to increase the number of RAP sources for future research and to collect existing information about the materials being recycled if possible.

Implementation:
Additional research is planned. The researchers have some historical data on work done on RAP in Mn/DOT's lab. Another RAP study is underway by Mn/DOT for the Local Road Research Board; a major part of which will be a comprehensive survey on local agency use of RAP. Selected pavements will be cored and laboratory analysis will be done on these cores to determine appropriate use of RAP.

Implementation Outcome:
Change with no measure

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200502.pdf

Report #2005-03

Principal Investigator:
Paul Bloom, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 81

Contract Period:
9/2/2003
to 12/31/2004

Funding:
$56,000 LRRB

Program:
CY2003 LRRB
INV 795

Screening Tool for Using Waste Materials in Paving Projects (STUWMPP)

Description:
This User Guide is intended to provide basic information that will enable users to take advantage of the features in the Screening Tool for Using Waste Materials in Paving Projects (STUWMMP) version 1.1 and to begin evaluating the potential environmental concerns for using waste materials in paving projects.

Conclusions:
This User Guide is intended to provide basic information that will enable users to take advantage of the features in the STUWMMP version 1.1 and to begin evaluating the potential environmental concerns for using waste materials in paving projects.

Implementation:
This software tool utilizes user-friendly interfaces to allow local government highway officials the ability to determine if their proposed waste-recycling project has the potential for regulatory non-compliance. It allows the user to use site-specific chemical values or default values from the database to determine if any given percent mixture of recycled wastes and other unbound materials presents the potential for non-compliance.

Implementation of this tool will provide local governments greater flexibility during road design and construction. The beneficial use of waste materials, such as fly ash, can provide economic and constructability benefits to road projects in large areas of Minnesota where weak subgrade soils are common.

Paul Bloom presented the project findings at the 2005 Minnesota Pavement Conference on February 17, 2005.

Implementation Outcome:
No Close-out memo

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200503.pdf

Related Projects:
81655 WO 154 INV 645: 2005/2006 Task 10 - "Screening Tool for Using Waste Materials (fly ash) in Paving Projects - Demo/Training"

Report #2005-04

Principal Investigator:
Rajesh Rajamani, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Maintenance

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 27

Contract Period:
9/16/2002 to 12/30/2004

Funding:
$58,000 Maintenance

Program:
Maintenance

GPS Based Real-Time Tire-Road Friction Coefficient Identification

Description:
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 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.

Conclusions:
The new wheel-based system developed in this project has several advantages compared to the popular Norse-meter, which is a commercially available redundant wheel-based system. The new wheel-based system has very few moving parts, requires no actuators for skidding the wheel and requires no braking of the wheel. It is expected to be more reliable and much less expensive than the Norsemeter. Experimental results presented in this report showed that the new wheel-based system worked effectively in determining friction coefficient and in measuring the change of friction coefficient during transition from one type of surface to another.

The developed friction identification systems have many applications in vehicle safety systems such as ABS, skid control and collision avoidance systems and are also useful for winter maintenance vehicles in which knowledge of the friction coefficient can be used to determine the amount and type of deicing chemicals to be applied to a winter roadway.

Implementation:
A follow-up project using the friction identification results together with other sensors for automatic closed-loop control of a sander on a snowplow is underway by the same researcher. Also, companies that develop vehicle saw stability control and vehicle roll prevention control systems may be interested in the tire-road friction identification algorithms, although no work has yet been done in that area.

Another ongoing follow-up project involves the researchers attempting to utilize the results to achieve automatic control of a snowplow sander.

Implementation Outcome:
Change with no measures

Report #2005-05

Principal Investigator:
Brent Phares, Iowa State University

Technical Liaison:
Dave Rholl, Winona County Engineer

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
82617 WO 6

Contract Period:
8/23/2004
to 12/30/2004

Funding:
$19,939 LRRB

Program:
CY2004 LRRB
INV 820

Impacts of Overweight Implements of Husbandry on Minnesota Roads and Bridges

Description:
The objective of the study is to analyze and identify the impacts of heavy agriculture vehicles on Minnesota pavements and bridges. This is critical because heavy agricultural loads can cause potential problems to the traveling public and adding to highway maintenance costs.

Conclusions:
The conclusion of this study validates the years of close observation of highway and bridge engineers that these heavy loads can cause potential problems in terms of both safety to the traveling public and added costs to the maintenance of the local system of highway infrastructure. It appears that the metric currently used to limit the weight of farm implements is not sufficient at predicting the potential for inducing damage to infrastructure.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200505.pdf

Related Projects:
"Best Practices for Maintaining and Upgrading Aggregate Roads in Australia" INV 769, Contract 81219
"Cost Comparison of Treatments Used to Maintain or Upgrade Aggregate Roads" INV 769, Contract 81219

Report #2005-06

Principal Investigator:
Satish Gupta, University of Minnesota

Technical Liaison:
Ruth Roberson, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 49

Contract Period:
11/4/2002
to 1/31/2005

Funding:
$108,000 STIP

Program:
Mn/DOT Transportation Research Program

Moisture Retention Characteristics of Base and Sub-base Materials

Description:
In this project, we generated soil moisture retention data of 18 non-recycled and 7 recycled materials used in pavement construction. The results showed that water retention of non-recycled materials was nearly similar.

Conclusions:
There is limited variation in the water retention characteristics of base and sub-base materials used for road construction in Minnesota. This is mainly because the particle size distributions of all the samples used in this study fall in a relatively narrow range. The major difference between the materials is the presence of large aggregates (>2 mm diameter), which contribute very little to water retention properties but have a strong influence on saturated hydraulic conductivity and thus on saturated water flow and drainage. These large aggregates, especially gravel, may also act as pathways for preferential movement of water. This data suggest that the use of water retention characteristics (more controlled by smaller particles) along with saturated hydraulic conductivity (more controlled by larger aggregates) to predict unsaturated hydraulic conductivity of roadbed materials (Eqs. [2] and [6]) may not be prudent. Studies should be undertaken to develop databases of road-bed materials of various aggregate sizes used in road-bed construction. These databases should then be used to develop Pedotransfer functions that can predict hydraulic conductivity of materials from simple parameters such as aggregate size distribution or gradation indices.

Several different types of Pedo-transfer function models are given in this report that can be used to predict water retention characteristics of base and sub base materials. These models include simple regression models that predict water retention at a given suction using bulk density and particle size distribution. Other models predict function (van Genuchten, Brooks-Corey, and Fredlund-Xing) parameters using similar input variables. However, one should be careful in using predicted function parameters to predict hydraulic conductivity using van Genuchten or Brook and Corey equations [Eqs. [2] and [6]). This is mainly because all three functions depend heavily on measured saturated hydraulic conductivity, which is mainly controlled by large aggregates.

Implementation: No Implementation Plan was written.

Implementation Outcome: No Close-out memo was written.
Report Located At: http://www.lrrb.gen.mn.us/pdf/200506.pdf

Report #2005-07

Principal Investigator:
Lee Peterson, Charles Nelson Associates

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract Number:
N/A

Contract Period:
N/A

Funding:
Demonstration Project

Program:
MnROAD

Continuous Compaction Control Demonstration

Description:
The report is on Continuous Compaction Control (CCC) demonstration conducted at MnRoad. Also known as Intelligent Compaction (IC), this is a new technique in the U.S. construction market.

Conclusions:
In September 2004, engineers conducted a CCC demonstration at MnRoad, an outdoor pavement test facility. CCC, also called Intelligent Compaction (IC), is a new technique in the United States construction market that uses an instrumented compactor to measure soil or asphalt compaction in real time and adjusts compactive effort accordingly to control the level of compaction. This demonstration used the BOMAG Compactor and focused on Young's soil modulus as the soil parameter of interest. CCC may potentially provide substantial benefits, including improved quality due to more uniform compaction, reduced compaction costs because effort is applied only where necessary, reduced life-cycle cost due to longer pavement life, and a stronger relationship between design and construction. State departments of transportation have expressed interest in exploring this method as a way of meeting quality-assurance requirements within a tight budget environment. In general, this study found CCC to be an effective quality-control mechanism for soil compaction. However, further questions arose as a result of the study and certain variables affected the results and measurements, including moisture content and the use of different measurement tools. Further research is needed to determine the level of uniformity in using CCC and the extent of reliability in achieving target values when using this method.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200507.pdf

Report #2005-08

Principal Investigator:
Jerry Fruin, University of Minnesota

Co-Principal Investigator:
Douglas Tiffany, University of Minnesota

Technical Liaison:
Robert Gale, Mn/DOT, Office of Freight and Commercial Vehicle Operations

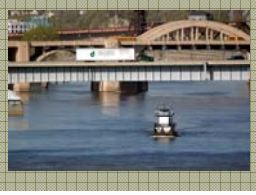
Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 55

Contract Period:
1/2/2003 to 1/31/2005

Funding:
$42,000 STIP

Program:
Mn/DOT Transportation Research Program



Distillate Usage Patterns in Minnesota: Development of Data and Tools To Analyze Policies Affecting Biodiesel Usage

Description:
This study was undertaken to assist policy- makers who may suggest utilization of biodiesel blends as part of an overall strategy to reduce ground level ozone and also to reduce immediate harm from particulate matter due to diesel engine exhaust.

Conclusions:
Diesel fuel and fuel oil usage patterns in Minnesota reflect the fact that diesel fuel is the "fuel of commerce." The usage patterns for diesel fuel and fuel oil provide an interesting frame of reference to observe all sorts of economic activity in the state. In order to comply with more stringent air quality standards and respond to air quality issues emerging due to greater congestion in the Minneapolis-St. Paul Metropolitan area, the usage patterns of diesel and fuel oil may suggest target categories of machines for various blends of biodiesel. Research with biodiesel reveals that in addition to restoring lubricity in ultra-low sulfur diesel fuel, emissions of particulates, poly-aromatic hydrocarbons, and VOC's will be reduced by usage of higher blends of biodiesel. The accompanying workbook was constructed in order to support analysis of policy choices that establish biodiesel blends for various categories of machines. The workbook can help policymakers focus on the categories of machines using distillate fuels and determine how much biodiesel would be required to provide blends for particular categories. As time goes by, the data populating the Data worksheet will become out of date. When this
occurs it will be possible to update the figures and use the workbook framework to estimate costs and the potential for emissions reductions possible by use of this renewable fuel.

Implementation:
No Implementation Plan written.
March 2005, Douglas Tiffany was asked to present findings to Minnesota House in support of a bill to direct more efforts to produce biodiesel fuels in Minnesota.
January/February 2005, Douglas Tiffany presented the workbook at a conference in Florida.
August 2004, demonstration of the spreadsheets occurred at the MPCA. Legislative and Mn/DOT staff also invited.
May 2004, a presentation made at CTS Research Conference.
February 2004, Douglas Tiffany presented results at CTS Environmental Research Council.

Implementation Outcome: No Close-out memo written.

Report Located At: http://www.lrrb.gen.mn.us/pdf/200508.pdf

Report #2005-09

Principal Investigator:
Charles Jahren, Iowa State University

Co-Principal Investigator:
Greg Johnson, Mn/DOT, Office of Materials

Technical Liaison:
Dave Christy, Itasca County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
82617 WO 1

Contract Period:
1/2/2003
to 1/31/2005

Funding:
$100,000 LRRB

Program:
CY2001 LRRB
INV 769

Economics of Upgrading an Aggregate Road

Description:
This report analyzes and compares the long-term costs associated with maintaining a gravel surface on low-volume roads with the cost of upgrading those same roads to a surface paved with hot mix asphalt.

Conclusions:
Research into cost comparisons between maintaining gravel surfaces on low-volume roads and paving and maintaining those same roads was conducted by studying the annual reports provided by 25 counties throughout greater Minnesota to Mn/DOT's State Aid Office. Researchers also conducted personal interviews with transportation officials in some of these counties. The result is an analytical method for estimating the cost of replacing (and maintaining) a gravel road with a surface paved with hot mix asphalt. Upgrading and maintenance activities that were quantified included maintenance grading, re-graveling, dust control and stabilization, reconstruction and regrading, among others. In examining and projecting costs, the authors conclude that depending on the use of historical cost figures may lead to an underestimation of the actual costs associated with maintenance. They also recommend that transportation officials give serious consideration to upgrading roads that experience an average traffic volume of 200 vehicles per day.

Implementation:
1) Having a tool to determine if it is economical to upgrade a gravel road gives the local engineers and decision makers objective information and data. 2) Provide a historical cost analysis based on the spending history for low volume roads found in the annual
3) Developing a two-page fact sheet to lead local agencies through this process is a first tool. 4) Training to get the word out about this new information can be the second method of implementation. This will give concrete objective information to aid in decision-making. That's a very valuable tool to local engineers and decision makers.

Implementation Outcome:
No Close-out memo written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200509.pdf

Related Projects:
81219 "Best Practices for Maintaining and Upgrading Aggregate Roads in Australia" INV 769

"Cost Comparison of Treatments Used to Maintain or Upgrade Aggregate Roads" INV 769

Report #2005-10

Principal Investigator:
Hani Titi, University of Wisconsin-Milwaukee

Technical Liaison:
Paul Rowekamp
Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
84297

Contract Period:
5/15/2003
to 1/31/2005

Funding:
$60,769 STIP

Program:
Mn/DOT Transportation Research Program

The Effect of Minnesota Aggregates on Rapid Chloride Permeability Tests

Description:
This study looks at the effect of the type of coarse aggregate used in concrete on chloride ions penetrability as indicated by the rapid chloride penetration test (RCPT). Twelve coarse aggregate types, commonly used in Minnesota Department of Transportation highway construction projects, were identified and used for this study.

Conclusions:
Twelve coarse aggregate types, commonly used in Minnesota Department of Transportation highway construction projects, were identified and used for this study. The coarse aggregate types were subjected to laboratory testing to determine their physical properties and ambient chloride content. The aggregate types were used to prepare fresh concrete according to Mn/DOT specifications in which silica fume and fly ash were used. In order to characterize the concrete in terms of resistance to chloride ions penetration, concrete specimens made of these aggregate types were subjected to the rapid chloride permeability test at different ages. All mix parameters including gradation and quantities of different aggregates were held constant in different mixes. The only variable was the aggregate type. For concrete specimens tested at 28 days of age, the average total charge passed varied between 1,452 and 2,606 Coulombs, which can be described as low to moderate chloride ions penetrability, according to AASHTO designation. The average total charge passed decreased with time (age) for all of the concrete specimens tested. Considering specimens at 91 days of age, the average total charge passed ranged from 601 to 1,236 Coulombs, which can be characterized as very low to low chloride ions penetrability. The aggregate type has a noticeable influence on the RCPT results for the concrete mix design that was utilized.

Implementation:
No Implementation Plan written.

Implementation Outcome:
No Close-out memo written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200510.pdf

Report #2005-11

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Technical Liaison:
Mark Maloney, City of Shoreview

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
83994

Contract Period:
5/1/2003 to 9/30/2005

Funding:
$22,100 LRRB

Program:
INV 645
2003/2004
LRRB—RIC
Task 8

Partners for Good: A Resource Guide for Partnership Efforts in Minnesota Cities and Counties

Description:
This report explores the use of partnerships from making efficient resource decisions to how major public works projects can be implemented through the concerted efforts of local government units.

Conclusions:
Joining forces in a partnership relationship is a way for different entities to come together and, building on their respective strengths and abilities, realize together what they could never have realized separately. Although partnership relationships are typically a profitable means for local governments to explore in implementing projects, they become even more compelling when resources are limited and multiple needs compete for scarce available dollars. This paper explores the use of partnerships in Minnesota to advance needed public works projects. It discusses some of the nuances of what partnerships can mean to local units of government, from the ways in which bartering of services, equipment, and staff expertise allows local units of government to make efficient resource decisions to how major public works projects can be implemented through the concerted efforts of interested partners. Through the use of focus group discussions, selected case studies, and the expertise of the Technical Advisory Panel (TAP) overseeing this effort, a best practices guide to Minnesota city and county partnering efforts results.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200511.pdf

Report #2005-12

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Technical Liaison:
John Rodeberg, City of Hutchinson

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
83994

Contract Period:
5/1/2003
to 9/30/2005

Funding:
$21,400 LRRB

Program:
INV 645: Implementation of Research Findings (2003-2004)

RIC Task 2

Project Management Software: Practical Applications for Improved Project Management

Description:
This paper looks at the various ways project management software is being utilized in Minnesota's transportation projects and how the right software is selected.

Conclusions:
Project management software is designed to make the job of a project manager easier and more efficient, providing applications to aid in planning, to manage project costs, and to track activities and monitor schedules. As more and more public works departments face the realities of increasing workloads and shrinking resources, finding technology applications that allow productivity gains becomes ever more important. The use of project management software as a tool for managing and organizing work has grown and continues to grow at a rapid pace in all industries. This paper reviews the ways in which it is currently being used in the course of transportation project delivery in Minnesota, and provides a tool to assist in choosing the right application to meet a local city or county's needs.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200512.pdf

Report #2005-13

Principal Investigator:
Cathy French, University of Minnesota

Co-Principal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
Scott Pierson, Mn/DOT, Office of Bridges

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 157

Contract Period:
1/18/2000 to 1/17/2005

Funding:
$180,000 STIP

Program:
Mn/DOT Transportation Research Program

Retrofitting Shear Cracks in Reinforced Concrete Pier Caps Using Carbon Fiber Reinforced Polymers

Description:
As a part of this study, the ultimate capacity of the pier cap overhangs was estimated by comparing predicted capacities calculated using standard design specifications to experimental results published in the worldwide literature.

Conclusions:
Mn/DOT documented the appearance of excessive cracks in the reinforced concrete pier cap overhangs of State Highway Bridges 19855 and 19856. As a part of this study, the ultimate capacity of the pier cap overhangs was estimated by comparing predicted capacities calculated using standard design specifications to experimental results published in the worldwide literature. It was determined that the ultimate capacity of the pier cap overhangs was more than sufficient to assure that a cracked, but undeteriorated, pier cap is not prone to structural failure. An estimate of the initial cracking load of the pier cap overhangs was also created to determine what changes to pier cap design would be required to prevent future overhangs from cracking. It was determined that the depth of the overhangs would have to be increased by approximately 20% to prevent them from cracking. The changes to pier cap overhang design required to prevent cracking or meet recommendations to reduce crack widths may not be economically feasible. Therefore, other methods for controlling crack widths must were examined. An experimental study was conducted to investigate the use of externally bonded (EB) FRP sheets and near surface mounted (NSM) FRP tape for shear strengthening of reinforced concrete beams. This report describes the experimental program, presents the results of the study, and discusses the outcome of that investigation.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200513.pdf

Report #2005-14

Principal Investigator:
Joseph Labuz, University of Minnesota

Co-Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Jihshya Lin, Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 19

Contract Period:
9/10/2001 to 3/31/2005

Funding:
$178,000 STIP

Program:
Mn/DOT Transportation Research Program

Earth Pressure Behind A Retaining Wall

Description:
The objective of the project was to determine the earth pressure behind a Mn/DOT reinforced concrete cantilever retaining wall.

Conclusions:
The data from this study show that Mn/DOT's design for cantilever retaining walls is reasonable, as active pressure developed. It is proposed that Mn/DOT's cantilever retaining wall design could be made more efficient by removing the shear key in certain situations. These situations would be limited to retaining walls 30 ft (9.1 m) or less in height, founded on granular soils, and for which the toe of the footing is covered with soil before the wall is completely backfilled. This "front-fill" should be granular and have properties similar to the design backfill material (γ = 125 pcf and f = 35°).

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200514.pdf

Report #2005-15

Principal Investigator:
David Levinson, University of Minnesota

Co-Principal Investigators:
Vaughan Voller, Mihai Marasteanu
University of Minnesota

Technical Liaison:
Anita Benson, Lyon County

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract Number:
81655 WO 47

Contract Period:
8/26/2002 to 4/30/2005

Funding:
$150,097 STIP
$150,098 LRRB

Program:
CY2002002
INV 785 and
Mn/DOT Transportation Research Program

Cost/Benefit Study of: Spring Load Restrictions

Description:
This study seeks to determine whether the haulers and the state of Minnesota would benefit from an approach that would tax truckers in some way to provide for upgrading the roads to the extent that they could be used year-round without restrictions.

Conclusions:
Across the state of Minnesota, asphalt roads under the jurisdiction of counties, cities and townships have been controlled by restrictions that limit the total weight of each truck that uses those roads during the spring thaw period. During this time, the pavement weakens and the bearing capacity of the roadway is reduced. These policies vary from county to county and from road to road, depending on the capacity of the roads--typically, 5, 7 and 9 tons. While spring load restrictions serve to extend the useful life of the road, they also add significant burdens to truckers who are forced to re-route their vehicles and/or increase the number of trips in order to adhere to the policies. This study assesses the economic impact of lifting all vehicle restrictions during the spring thaw period. Economic benefits of lifting the bans include reduced cost to carriers; potential cost includes reduced pavement life. Their research concludes that if the policy is changed, the costs of additional damage could be recovered from those who use the roads. Recovering those costs could take the form of annual fees, appropriate fuel taxes and/or user charges paid by vehicle operators.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200515.pdf

Related Projects:
81655 WO 138 “Spring Load Restriction Study” INV 818:

Report #2005-16

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Richard West, Otter Tail County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
81655 WO 48

Contract Period:
1/2/2003 to 3/31/2005

Funding:
$25,000 LRRB

Program:
CY2002 LRRB INV 781

The Effects of In-Lane Rumble Strips on the Stopping Behavior of Sleep-Deprived Drivers

Description:
The second in a series of three studies, this research investigates the effect of in-lane rumble strips on the stopping performance of sleep-deprived drivers. This segment of the research used a simulator to test 20 commercial drivers who drove for approximately one hour four times throughout a 20-hour period during which they were continuously awake.

Conclusions:
The key finding of the study was that, despite the fatigue of the drivers, the *braking pattern* of the drivers was affected by the presence of the rumble strips. From the appearance of the first set of rumble strips, 218 meters (715.2 ft) from the intersection up to the point at which the drivers stopped, the mean speed of drivers approaching the intersection *with* the rumble strips was statistically significantly slower than the mean speed for drivers approaching the intersection *without* the rumble strips.
The finding that rumble strips consistently affected the stopping pattern of the drivers on their four drives is made more evident in that there was no statistically significant difference in mean speeds on the two intersection approaches before the drivers reached the point on the approach where the rumble strips occurred. The *presence* of rumble strips caused the drivers to brake to a greater extent earlier in the approach.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200516.pdf

Related Projects:
74708 WO 190 "Effectiveness of In-Lane Rumble Strips" INV 763

Report #2005-17A and #2005-17B

Principal Investigator:
Lee Munnich, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
74708 WO 115

Contract Period:
8/3/1999 to 10/31/2000

Funding:
$157,500 Guidestar
$157,500 STIP
$12,500 IVHS Research

Program:
ITS and Mn/DOT Transportation Research Program

Telework, Telecommunications and Community Design and Measuring Our Path to the Future: Using Indicators of Sustainable Development in Transportation Planning

Description:
This project will: 1) establish an ongoing forum for reviewing State and Local Policy Program (SLPP) research activities and products in as objective, independent and credible a manner as possible; 2) refine measures of sustainable transportation and enhance their applicability in community and regional planning and policy making; and 3) develop in-depth information about the behavioral issues surrounding telework and develop a set of integrated ITS and telecommunications design, planning and evaluation guidelines for communities based upon telework attitudes and behavior.

Conclusions:
Report#2005-17A: as the opportunity exists for networked telecommunications to have a greater impact on transportation, the economy, society, and, potentially, the environment combined than other present trends, it seems essential that stakeholders, such as private developers, citizens, local jurisdictions and public agencies become aware of the complex issues and opportunities at hand. In light of these present trends, telecommunications as a mode of accessing goods and services and as a mode of travel holds promise as the one most likely to be embraced by the public and most flexibly meet their way-of-life needs. Eleven recommendations and findings from the research project are listed in the report.

Report#2005-17B:
Significant findings of the research include:
1) The state of the art in measuring progress toward sustainable transportation systems involves tracking indicators and applying them through the use of visualization techniques and mapping
2) The capacity for assessing indicators of sustainability or smart growth varies widely by region; in particular rural areas seem to lack the capability to do so
3) There are community planning techniques, such as the TAM Process, that can integrate the overall concept of environmentally-responsive transportation systems into local transportation planning efforts, though these have yet to utilize innovative planning methodologies
4) In the urban context, there is considerable data for assessing transportation impacts, yet the relationship between transportation, the built environment, and the surrounding community is quite complex and requires an integrated policy approach and understanding.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
Call Sandy McCully at 651/282-2272 for information on the reports.

Report #2005-18

Principal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 30

Contract Period:
10/7/2002
to 4/29/2005

Funding:
$30,000
Maintenance

Program:
Maintenance

DGPS-Based Gang Plowing

Description:
This report covers three areas. First, to improve driver visibility, an implementation of the virtual mirror to the left side of the trailing plow is described. Second, the lateral and longitudinal performance of a two-vehicle gang on Minnesota Trunk Highway 101 is described. Third, a system architecture for gangs of more than two vehicles is proposed, and its potential performance is documented through simulation.

Conclusions:
An operational gang plowing system has been demonstrated to work on a Minnesota Trunk Highway. Although the ultimate goal was to perform operational tests in poor weather and low visibility conditions, mild winter weather, combined with a shortage of Mn/DOT snowplowing staff, rendered poor weather testing impossible. However, on road testing in good weather did show that the system was sufficiently developed for operational gang plowing. Had more resources been available, that testing could have taken place. Also important is the development of an architecture to support longer gangs. The simulator effort indicates that the architecture would support a much larger gang provided timely, robust communications can be provided. Modern wireless technology (802.11b, g, and Mesh Networks) provides the robust, high bandwidth wireless communication needed by large vehicle gangs.

One application in particular which would benefit greatly from this large vehicle gang capability is winter airport runway maintenance. Airport personnel have only a short time to clear a runway during periods of heavy snow. For example, at MSP International, a gang of up to 24 vehicles will be used to clear a runway. The first wave of vehicles are trucks which use a conventional plow blade; the distance between the blade and the runway is maintained between three and five centimeters. This is done to prevent damage to the tarmac. Behind the snowplows are snow brushes; the job of the snow brush is to remove the last three to five centimeters of snow from the tarmac. Finally, two large snowblowers follow the main gang to blow the snow moved by the plows and brushes up to 150 meters from the runway.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200518.pdf

Report #2005-19

Principal Investigator:
William Gartner, University of Minnesota

Technical Liaison:
Peter Buchen, Mn/DOT, Office of Aeronautics

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 76

Contract Period:
6/15/2003
to 5/31/2005

Funding:
$80,000 Aeronautics Construction Grant

Program:
Mn/DOT Transportation Research Program

Development of a Web-Based Economic Impact Calculator for Small and Medium Size Airports

Description:
This report details the development of a Web-based economic impact calculator
for 136
General Aviation airports in Minnesota with the exception of Minneapolis/St. Paul, Rochester, and Duluth International.

Conclusions:
This report details the development of a Web-based economic impact calculator for Minnesota's Small and Medium Size, General Aviation airports. In this case, economic impact is defined as the result of expenditures or sales transactions between businesses or other entities that can be directly traced to the presence of an airport. The process involved site visits to 51 airports, meetings with airport managers, Fixed Base Operators (FBO), and Metropolitan council officials, as well as data collection of financials from airport sponsors and FBOs. After testing on the calculator was completed, it was transferred to the Mn/DOT Aeronautics server and can be found at http://dotapp1.dot.state.mn.us:8080/aeic/main.htm. We recommend, however, that a new effort be considered to obtain more detailed financials for FBOs as a way to improve calculator accuracy. Although the current model provides a good estimation of FBO expenditures, greater accuracy could be obtained with more data.

Implementation:
Tool Demo done on April 28, 2004 at MCOA with over 250 people in audience.
Presentation on project made at the Obestar forum in Duluth on March 14, 2004.

No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200519.pdf

Report #2005-20

Principal Investigator:
David Levinson, University of Minnesota

Technical Liaison:
Debra Fick, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 95

Contract Period:
4/22/2004 to 5/30/2005

Funding:
$57,765 Guidestar
$14,440 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Route Preferences and the Value of Travel-Time Information for Motorists Driving Real-World Routes

Description:
This research focuses on the potential for alleviating some congestion during peak travel times by providing drivers with accurate, updated travel-time information about the routes they are most likely to take.

Conclusions:
This experiment analyzes results based on a field test of 117 drivers completing the same point-to-point trip in their own vehicles via five different routes. Participants traveled both arterial and freeway routes, assessed the travel information that was provided, evaluated the importance of the accuracy of the information and charted their route preferences for various trip purposes. Researchers were not looking merely for perceived time savings but driver perception of the value of the time saved in order to make projections about whether drivers would be willing to pay for accurate travel updates as a means of reducing overall cost, anxiety and uncertainty while driving. Knowledge of how much users want to pay for Advance Travel Information System (ATIS) services is necessary for the design of sustainable for-profit private services or private/public partnerships.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200520.pdf

Report #2005-21

Principal Investigator:
Tom Maze, Iowa State University

Co-Principal Investigators:
Luke Plagge and Dennis Kroeger, Iowa State University

Technical Liaison:
Robert Gale, Mn/DOT, Office of Freight and Commercial Vehicle Operations

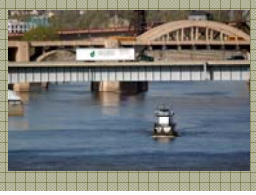
Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
82617 WO 5

Contract Period:
7/12/2004 to 7/31/2005

Funding:
$79,689 STIP

Program:
Mn/DOT Transportation Research Program



Trucks and Twin Cities Traffic Management

Description:
The study first identified an exhaustive list of potentially feasible strategies and then through iterative steps narrowed these down to the most promising.

Conclusions:
The recommendations made include the following five:
1. Development of Minnesota guidance for planning, designing, specifying, and maintaining transportation facilities around heavy truck traffic generators. The guidance manual will help local governments better accommodate the transportation infrastructure demand of heavy truck generators and truck-oriented development. When the manual is first introduced, it is recommended that a training program be developed to accompany the manual's introduction.
2. Outreach to explore legislation to hold Mn/DOT and enforcement agencies harmless from liability when conducting quick clearance activities. Many other states have found it necessary to hold first responders harmless from liability so that they can more aggressively clear disabled vehicles and spilled cargo from the roadway. There are clear benefits and costs related to protecting first responders from liability when they move vehicles and freight without the owner's permission. These issues need to be explored further. Thus, it is recommended that the Office of Traffic, Security, and Operations develop an outreach plan to that end.
3. Increase commercial vehicle parking supplies on the urban fringe. There is a growing need for increased overnight truck parking around the Twin Cities. It is recommended that the Mn/DOT identify its role in providing truck parking, then reconsider the recommendations made in the 2001 Mn/DOT study "Nighttime Commercial Vehicle Parking Demand at 15 High-Use Minnesota Rest Areas."
4. Improve advanced guide signage for freeway entrances. Mn/DOT is in the process of reviewing the 2003 MUTCD and then adopting the expanded guidance for interchange approach guide signs. Once adopted, Mn/DOT will begin upgrading its guide signs. Since this will take several years, it is recommended that the Office of Freight and Commercial Vehicle Operations work with district traffic engineers to define priorities for the interchange locations that should be upgraded first.
5. Develop longer and truck-friendly acceleration and deceleration lanes. There is evidence that acceleration lanes are too short for the performance characteristics of typical semitractor-trailer trucks. Therefore, at locations where there are high truck volumes, designers should consider longer acceleration lanes and the use of median left-turn acceleration lanes. It is recommended that the Office of Freight and Commercial Vehicle Operations work with the appropriate offices to develop explicit criteria to be considered. There is no cost for spelling out the need to accommodate the performance characteristics of heavy trucks in the guidance offered in the "Minnesota Comprehensive Highway Safety Plan" and in Mn/DOT's "Road Design Manual."

Implementation:
The recommendations resulting from this research will require support from several different offices in Mn/DOT and will likely need expertise from external public/private sources. The cost for implementing some of the recommendations will be an effort requiring cooperation from a number of functional areas of Mn/DOT including design, bridges, materials, traffic, and standards to name a few. Buy-in from local government will also be necessary. The plan for full implementation of this research is on a much broader scale than most projects. It will require building upon the report recommendations and refining them to a level of detail required to ensure accomplishment of implementation.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200521.pdf

Report #2005-22

Principal Investigator:
Timothy McGrath, Simpson Gumpertz & Heger Inc

Technical Liaison:
Eric Wolhowe, Mn/DOT, Office of Bridges

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
No Contract

Contract Period:
N/A

Funding:
$100,000 LRRB
$200,000 FHWA
$275,000 from Mn/DOT, Pipe Industry, Bridge

Program:
CY2002
LRRB
INV 752

Performance of Thermoplastic Pipe Under Highway Vehicle Loading

Description:
Mn/DOT initiated a project to investigate the performance of large diameter corrugated polyethylene (PE) pipe installed under highway vehicle loading and to improve methods of analysis and design for this condition.

Conclusions:
Corrugated PE pipe is available in diameters up to 60 in., but questions remain as to its expected performance under substantial live loads in shallow fill conditions. Full scale testing and computer modeling have been conducted to investigate issues associate with this application.

Under moderate live loads for a period of 3.5 years the pipe has performed well. No deterioration has been noted in the condition of the pipe. The response to live loads at depths of fill of 1.5 ft and 2.5 ft was minimal; however, due to the high coefficient of thermal expansion and the temperature extremes in the Minnesota environment, the pipe expansion and contraction did cause the pavement surface to become rough, eventually cracking the pavement over the pipes. Cracking over the pipes at a depth of 1.5 ft of fill was substantial. The effect was significantly reduced over the pipes with 2.5 ft of fill, and the pavement performance was much better. As a result, the recommended minimum depth of cover is the maximum of 2 ft or 0.5 times the pipe diameter. At this minimum depth, the pipe structural performance will be excellent, and the effect on roadway performance should be minimal if installed according to the recommended practice.

Design equations for predicting deflection, bending moment and hoop thrust were developed and presented in the form of a complete design method for thermoplastic pipe. Design examples are provided.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200522.pdf

Report #2005-23

Principal Investigator:
John Gulliver,
University of Minnesota

Technical Liaison:
Mike Eastling,
City of Richfield

Administrative Liaison:
Barb Loida,
Mn/DOT

Contract Number:
81655 WO 78

Contract Period:
6/9/2003
to 9/30/2005

Funding:
$98,000
LRRB

Program:
CY2003 LRRB
INV 800

The Cost and Effectiveness of Stormwater Management Practices

Description:
The results of this research can be used by planners and designers to estimate both the total cost of installing a stormwater management practice at a given site, and the corresponding total suspended solids and phosphorus removal.

Conclusions:
Stormwater management practices for treating urban rainwater runoff were evaluated for cost and effectiveness in removing suspended sediments and phosphorus. Construction and annual operating and maintenance cost data was collected and analyzed for dry detention basins, wet basins, sand filters, constructed wetlands, bioretention filters, infiltration trenches, and swales using literature that reported on existing SMP sites across the United States. After statistical analysis on historical values of inflation and bond yields, the annual operating and maintenance costs were converted to a present worth based on a 20-year life and added to the construction cost. The total present cost of each SMP with the 67% confidence interval was reported as a function of the water quality design volume or, in the case of swales as a function of the swale top width, again with a 67% confidence interval. Finally, the mass of total suspended solids and total phosphorus removed over the 20-year life was estimated as a function of the water quality volume. The results can be used by planners and designers to estimate both the total cost of installing a stormwater management practice at a given site and the corresponding total suspended solids and phosphorus removal.

Implementation:
Presentation made of research results at CTS Research Conference on April 26, 2005.

No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200523.pdf

Report Relates To:
81655 WO 75 “Impact of Alternative Storm Water Management Approaches on Highway Infrastructure” INV 799

Report #2005-24

Principal Investigator:
Kevin Krizek,
University of Minnesota

Technical Liaison:
Adeel Lari,
Mn/DOT,

Administrative Liaison:
Barb Loida,
Mn/DOT

Contract Number:
81655 WO 50

Contract Period:
12/1/2002
to 6/30/2005

Funding:
$38,350
STIP

Program:
Mn/DOT
Transportation
Research Program

User Perspectives on Location Efficient Mortgages & Car Sharing

Description:
The goal of this research is to evaluate this initiative, as well as position it within the broader goals of smart growth, describe its application, and comment on its prospects.

Conclusions:
A burgeoning population seeking relatively affordable housing is placing high demands on outlying, auto-dependent residential markets. Simultaneously, public policies addressing housing, transportation, and land use aim to increase homeownership, decrease drive-alone travel, and harness outlying development. A relatively new mortgage lending procedure aims to address each of these public policy aims synergistically by allowing low- and moderate-income households the opportunity to purchase homes in transit-accessible neighborhoods that would otherwise be unobtainable because of cost. The goal of this research is to evaluate this initiative, as well as position it within the broader goals of smart growth, describe its application, and comment on its prospects. This report constitutes a primer of the current state of knowledge about these unique loan programs.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200524.pdf

Report #2005-25

Principal Investigator:
Mihai Marasteanu,
University of Minnesota

Co-Principal Investigator:
Raymond Hozalski,
University of Minnesota

Tim Clyne,
Mn/DOT, Office of Materials (currently)

Technical Liaisons:
Duane Blanck,
Crow Wing County

Greg Johnson,
Mn/DOT, Office of Materials

Administrative Liaison:
Jim Aamot,
Mn/DOT

Contract Number:
81655 WO 79

Contract Period:
7/1/2003
to 7/31/2005

Funding:
$58,996
LRRB

Program:
CY2003 LRRB
INV 798

Preliminary Laboratory Investigation of Enzyme Solutions as a Soil Stabilizer

Description:
Enzymes as soil stabilizers have been used to improve the strength of subgrades due to low cost and relatively wide applicability compared to standard stabilizers.

Conclusions:
This research studied the effect of two enzymes as soil stabilizers on two soil types to determine how and under what conditions they function. Researchers evaluated the chemical composition, mode of action, resilient modulus, and shear strength to determine the effects of the enzymes A and B on the soils I and II. The enzymes produced a high concentration of protein and observations suggest the enzymes behave like a surfactant, which effects its stabilization performance. The specimens were subjected to testing of varying lengths of time to determine their performance. Researchers observed an increase in the resilient modulus as the curing time increased but that an increase in application rate, as suggested by manufacturers, did not improve the performance of the enzymes. The study also suggests noticeable differences between the two enzymes and their effects on the soils in terms of resilient modulus and the stiffness of the soil.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200525.pdf

Report #2005-26

Principal Investigator:
Thomas Stinson, University of Minnesota

Co-Principal Investigator:
Barry Ryan, University of Minnesota

Technical Liaison:
Ken Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 89

Contract Period:
11/15/2003 to 6/30/2005

Funding:
$89,100
STIP

Program:
Mn/DOT Transportation Research Program

Minnesota State Road Taxes in 2030: Will Revenues Keep Pace With Inflation?

Description:
According to this research, current tax policy can support 2003 service levels into the future, but not fund system improvements.

Conclusions:
The future adequacy of Minnesota road funding is evaluated in a 27-year forecast of current law road taxes (motor vehicle registration tax, motor vehicle sales tax, and motor fuels excise tax). Revenue projections are compared with inflation-adjusted base costs in three economic growth scenarios (Trend, Optimistic, and Pessimistic), using two price deflators (core-CPI and state/local government costs). The Trend scenario predicts road tax revenues will lose purchasing power to inflation by 2020, but over the forecast period cumulative revenues and costs nearly balance out. According to this scenario, current tax policy can support 2003 service levels into the future, but not fund system improvements. The Optimistic scenario forecasts a surplus in purchasing power in all 27 years, providing the opportunity for significant new spending without changing current law. Under the Pessimistic scenario, tax revenues fall short of inflationary costs by 2012, with the annual loss in purchasing power reaching $1 billion by 2030. In this scenario, road tax policy changes are needed to avert significant declines in road service.

Implementation:
No Implementation Plan was written.

Barry Ryan gave a presentation on November 23, 2005 to the Office of Investment Management's managers and supervisors. It was also presented to the legislature in February 2005.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200526.pdf

Report #2005-28

Principal Investigator:
James Wilde, Mankato State University

CoPrincipal Investigator:
Bill Zerfas, Formerly Mn/DOT, Office of Materials

Technical Liaison:
John Brunkhorst, McLeod County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
85056

Contract Period:
5/15/2003
to 7/31/2005

Funding:
$27,500
LRRB

Program:
CY 2003
LRRB
INV 802

Occurrence of Bumps in Overlays

Description:
Under this project, a survey was conducted of local and state engineers in Minnesota responsible for highway construction and maintenance to compile corrective actions that they have used avoid these bumps and to mitigate their effects if they occur.

Conclusions:
The primary theory evaluated under this project, and the two others that were subsequently evaluated did not show a likelihood for causing bumps in overlays. The major benefits of this project, however, are the overlay projects database and the guidelines document which were created.

The project team recommends that a more focused investigation into the compression and rebound theory be conducted. Another recommendation is that additional study be conducted to predict the probability of the occurrence of bumps in overlays. This project dealt with the prevention and mitigation of bumps, but further study should be undertaken to identify the combination of parameters that have a high probability of producing bumps.

The project team also recommends that the LRRB publish the information in a pamphlet or by other means, to disseminate the information gained during this project. The information contained in Appendix B can be set in a format that will be easily usable by design and construction personnel representing the highway agency as well as the contractor. Using this information, designers can plan for contingencies in the case that bumps occur. They can also use past experience as an indicator, along with this information, to decide if mitigation procedures are necessary.

Implementation:
Jim Wilde gave presentation at the Minnesota Asphalt Pavement Conference in March of 2006.
Bill Zerfas gave presentation at the 2004 TRB conference.
Jim Wilde gave this presentation to the Materials Engineers Organization (MEO) in November 2003.
Jim Wilde gave presentation of the "up to date findings" at the Minnesota Asphalt Pavement Conference in December 2003.

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200528.pdf

Related Projects:
85056 “Performance of Pavement. Crack Sealants Beneath Bituminous Overlays” INV 802

89218 “Predicting the Occurrence of Bumps in Overlays” INV 843

Report #2005-29

Principal Investigator:
Eugene Takle, Iowa State University

Technical Liaison:
Curt Pape, Mn/DOT, Office of Maintenance

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Number:
82617 WO 2

Contract Period:
1/2/2003
to 4/29/2005

Funding:
$59,205 Aurora
$25,000 Pooled Fund

Program:
Aurora
SPR-3(042)

Test and Validation of a Model for Forecasting Frost on Bridges

Description:
Accurate forecasts of frost onset times, density and disappearance are necessary to help roadway maintenance personnel make decisions about the application of frost-suppression chemicals. This project analyzed the effectiveness of BridgeT, a finite-difference program, in predicting bridge surface temperatures.

Conclusions:
condition. BridgeT is a numerical model for heat transfer in a concrete bridge that takes atmospheric values from a weather forecast model and calculates bridge surface temperature, frost depth, and bridge conditions. It accounts for heat fluxes due to solar and long wave radiation, conduction through the bridge, convection on the top and bottom surfaces, and latent heat effects through explicit forward-difference numerical methods.

Comparisons of its results with measured surface temperatures from an RWIS station have demonstrated that BridgeT realistically represents early-morning low temperatures and temperature trends when run with input from observations of air temperature, wind speed, and
radiation. Some of the error can be attributed to spatial separation (19 km) of the bridge temperature observation site and the radiation observation site.

BridgeT is capable of supplying surface temperatures within 1K of measured values over a 40-h forecast period if it is supplied with accurate weather forecasts. RWFS-BridgeT has shown reasonable skill in surface temperature and frost prediction although the nighttime cooling rate is
typically too steep, likely due to RWFS long wave radiation errors. RWFS-BridgeT tends to over-predict frost but also has a high probability of predicting all frost events. These traits are consistent with the steep nighttime temperature trends associated with RWFS-BridgeT. MM5-
BridgeT has shown slightly better skill in bridge temperature prediction; although calibration improved overall performance, calibration was not as effective at improving the forecast as was true for RWFS-BridgeT. Frost predictions were prone to false alarms and partial hits, largely
due to humidity and precipitation errors from MM5.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At: http://www.lrrb.gen.mn.us/pdf/200529.pdf

Report #2005-30

Principal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
Rick Kjonaas, Mn/DOT, Office of State Aid

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 16

Contract Period:
11/19/2001
to 10/31/2005

Funding:
$141,860
LRRB

Program:
CY 2001
LRRB
INV 774

Driver Assistive Systems for Rural Applications: A Path to Deployment

Description:
Volume 1. The Intelligent Vehicles Lab (IV Lab) at the University of Minnesota has developed a wide range of driver assistive systems. One such system is designed to assist a driver maintain lane position and avoid collisions under low visibility conditions.

Conclusions:
Deployment of any system is driven by market demand and system cost. Initial deployment of the Intelligent Vehicle Lab Snowplow Driver Assistive System (DAS) was limited to a 45 mile section of Minnesota Trunk Highway 7 west of I-494 and east of Hutchinson MN. To better gage demand and functionality, St. Louis and Polk Counties in Minnesota operationally tested the system during the winter of 2003-2004; Polk County also tested during the winter of 2004-2005. Operational benefits were found to be drastically different in the two counties. Low visibility was not an issue with the St. Louis County snowplow routes, so the system offered few benefits. In contrast the topology of Polk county is flat, with almost no trees. High winds combined with few visual cues create significant low visibility conditions. Polk County was pleased with their original system, and obtained a second system and tested it operationally during the 2004-2005 winter. The experience of these two counties is documented in this volume, Volume One.

A key component of the DAS is a high accuracy digital map. With the exception of the mapping process, the present cost of the DAS is well documented. Volume Two describes a system designed to collect and process geospatial data to be used by driver assistive system, and the costs and time associated with collecting map data, and creating a map from that data. With cost data complete, counties can determine whether to acquire these systems.

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200530.pdf

Report #2005-31

Principal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
Rick Kjonaas, Mn/DOT, Office of State Aid

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 16

Contract Period:
11/19/2001
to 10/31/2005

Funding:
$141,860
LRRB

Program:
CY 2001
LRRB
INV 774

Driver Assistive Systems for Rural Applications: Digital Mapping of Roads for Lane Departure Warnings

Description:
Volume 2. This volume describes a system designed to collect and process geospatial data to be used by driver assistive system, and the costs and time associated with collecting map data, and creating a map from that data.

Conclusions:
Deployment of any system is driven by market demand and system cost. Initial deployment of the Intelligent Vehicle Lab Snowplow Driver Assistive System (DAS) was limited to a 45 mile section of Minnesota Trunk Highway 7 west of I-494 and east of Hutchinson MN. To better gage demand and functionality, St. Louis and Polk Counties in Minnesota operationally tested the system during the winter of 2003-2004; Polk County also tested during the winter of 2004-2005.

Operational benefits were found to be drastically different in the two counties. Low visibility was not an issue with the St. Louis County snowplow routes, so the system offered few benefits. In contrast the topology of Polk county is flat, with almost no trees. High winds combined with few visual cues create significant low visibility conditions. Polk County was pleased with their original system, and obtained a second system and tested it operationally during the 2004-2005 winter. The experience of these two counties is documented in Volume One.

A key component of the DAS is a high accuracy digital map. With the exception of the mapping process, the present cost of the DAS is well documented. This volume, Volume Two, describes a system designed to collect and process geospatial data to be used by driver assistive system, and the costs and time associated with collecting map data, and creating a map from that data. With cost data
complete, counties can determine whether to acquire these systems.

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200531.pdf

Report #2005-32

Principal Investigator:
Shongtao Dai, Mn/DOT, Office of Materials

CoPrincipal Investigator:
Dave Van Deusen, Mn/DOT, Office of Materials

Technical Liaison:
Larry Berkland, Steel County

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
No Contract

Contract Period:
N/A

Funding:
$46,200
LRRB

Program:
CY 2003
LRRB
INV 794

Improvement and Validation of Mn/DOT DCP Specifications for Aggregate Base Materials and Select Granular

Description:
To increase construction speed and save costs, Mn/DOT has implemented Dynamic Cone Penetrometer (DCP) specifications for aggregate base materials since 1997. Since the DCP test is a simple, quick, and inexpensive test, it can save inspection time, ultimately saving on construction costs. However, moisture and gradation effects on DCP index are not considered in the current specifications. In addition, there is no DCP specification for select granular, a common grading material used in Minnesota.

Conclusions:
The major purpose of this project was to verify and improve the trial Mn/DOT DCP specification developed in 2002 through additional field tests and implementation on several pilot construction projects. Eleven construction projects from around the state were selected for testing during the summer of 2003. At each construction project, several locations were randomly selected for testing. At each location, various devices were used to obtain in-situ stiffness, strength, density and moisture data. In addition, samples were also taken for gradation and Proctor tests from the majority of the test locations. The materials included Select Granular, CL3, CL5, CL6, CL7 and full-depth reclamation. The proposed DCP specification from 2002 testing was validated and modified using the 2003 data.

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200532.pdf

Report #2005-35

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 93

Contract Period:
1/2/2004 to 9/30/2005

Funding:
$50,000 STIP

Program:
Mn/DOT Transportation Research Program

The Financial Benefits of Early Acquisition of Transportation Right of Way

Description:
The first part of the analysis is very general, comparing rates of price increase for different types of properties to the opportunity costs of holding land, over a long historical period. The second part of the analysis focuses on Minnesota and examines property price increases by county over shorter, more recent, time periods.

Conclusions:
This report addresses the question of whether there are financial benefits to acquiring transportation right of way far in advance of when the improvement will be done. The first part of the analysis is very general, comparing rates of price increase for different types of properties to the opportunity costs of holding land, over a long historical period. The second part of the analysis focuses on Minnesota and examines property price increases by county over shorter, more recent, time periods.

While it is almost certainly worthwhile to acquire land that is in danger of becoming developed, this analysis did not find much apparent financial value in early purchase of land that is already developed, or is not likely to become developed. While there could be localized exceptions, prices of these types of land do not in general rise fast enough to offset the opportunity cost of the money that is used to purchase them. However, there could be other, non-financial benefits associated with early purchase that could compensate for some of the costs involved.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200535.pdf

Report #2005-36

Principal Investigator:
Francis Harvey, University of Minnesota

Co-Principal Investigator:
William Craig, University of Minnesota

Technical Liaison:
Rick Morey, Mn/DOT, Office of Land Management

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
81655 WO 122

Contract Period:
7/21/2004 to 10/31/2005

Funding:
$47,354
STIP

Program:
Mn/DOT Transportation Research Program

Enhanced Coordination of Cadastral Information

Description:
The timely and accurate identification sharing and coordination of cadastral information is the basis for well-managed highway projects.

Conclusions:
Any Mn/DOT project conducted by Mn/DOT that impacts property owners requires the coordination of cadastral (land ownership) and highway right-of-way
information. The timely and accurate identification sharing and coordination of cadastral information is the basis for well-managed highway projects. Mn/DOT has already taken a step towards improving coordination between Mn/DOT offices and other government agencies with the State Parcel Map Inventory (SPMI), a resource with information about the status and accuracy of cadastral information in 87 Minnesota counties. Government agencies have seen the potential in the SPMI to better optimize data development and exchange through the use of GIS technologies. The finding of this project suggest that the SPMI is a starting point for helping coordination, but more targeted efforts are called for. Considering the heterogeneity of local government, individual relationships between organizational staff are crucial to overcoming institutional and technical obstacles.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200536.pdf

Related Project:
81655 WO 37 “GIS Parcel Map Inventory”

Report #2005-37

Principal Investigator:
Brian Scott, SRF Consulting Group, Inc.

Co-Principal Investigator:
Erik Minge, SRF Consulting Group, Inc.

Technical Liaison:
Jerry Kotzenmacher, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
82139 WO 5

Contract Period:
6/2/2003
to 9/30/2005

Funding:
$222,988
Pooled Fund

Program:
2003 SP&R
TPF-5(073)

Evaluation of Portable Non-Intrusive Traffic Detection System

Description:
This project developed an accurate, simple, cost-effective, portable and safe method of collecting traffic, as well as, examined the ease of system setup, system reliability, and flexibility.

Conclusions:
Traditional traffic data-collection methods, such as inductive loops and road tube counters, require intrusion into the roadway to install. This creates traffic interruptions and safety concerns as personnel are exposed to traffic during installation. This project developed an accurate, simple, cost-effective, portable and safe method of collecting traffic. The "Portable Non-Intrusive Traffic Detection System" (PNITDS) provides an alternative to conventional methods by allowing agencies to collect data in high-traffic locations without compromising traffic flow or personnel safety.

Mn/DOT is the lead state in conducting the PNITDS evaluation test. The project is supported by 16 other participating state DOTs through a pooled-fund effort. The purpose of this project is to provide data-collection practitioners with a cost-effective PNITDS system design. The project fabricated and field-tested a prototype system. This system was then demonstrated to participating pooled fund states for onsite training. The selected design consists of a battery-powered, pole-mounted system that serves as a platform for mounting side-fired non-intrusive traffic sensors. Three sensors were evaluated: the RTMS by EIS, the SAS-1 by SmarTek, and the SmartSensor by Wavetronix. Field-test results were
obtained for volume, speed and length-based vehicle classification under a variety of mounting configurations. The project also examined the ease of system setup, system reliability and flexibility. An additional test was conducted to assess a newly developed sensor, The Infra-Red Traffic Logger (TRITL), for its ability to collect axle-based vehicle classification data. Test method and results are included in the project's final report.

Implementation:
No Implementation Database

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200537.pdf

Report #2005-38

Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Paochen Mma, Mn/DOT, Office of Bridges

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 120

Contract Period:
7/12/2004 to 10/31/2005

Funding:
$49,500 STIP

Program:
Mn/DOT Transportation Research Program

Analysis of Girder Differential Deflection and Web Gap Stress for Rapid Assessment of Distortional Fatigue Stress in Multi-Girder Steel Bridges

Description:
The purpose this project was to refine and reformulate the previously developed equations of estimating stresses in steel girder webs to out-of-plane distortion. In addition, this project introduced dual-level analyses including both macro-models and micro-models of the two field-monitored bridges.

Conclusions:
Distortion-induced fatigue cracking in unstiffened web gaps is common in steel bridges. Previous research by Mn/DOT developed methods to predict the peak web gap stress and maximum differential deflection based upon field data and finite element analyses from two skew supported steel bridges with staggered bent-plate and cross-brace diaphragms, respectively. This project aimed to test the applicability of the proposed methods to a varied spectrum of bridges in the Mn/DOT inventory. An entire bridge model (macro-model) and a model encompassing a portion of the bridge surrounding the diaphragm (micro-model) were calibrated for two instrumented bridges. Dual-level analyses using the macro and micro-models were performed to account for the uncertainties of boundary conditions. Parameter studies were conducted on the prototypical variations of the bridge models to define the sensitivity of diaphragm stress responses to typical diaphragm and bridge details. Based on these studies, the coefficient in the web gap stress formula was calibrated and a linear prediction of the coefficient was proposed for bridges with different span lengths. Additionally, the prediction of differential deflection was calibrated to include the influence of crossbrace diaphragms, truck loading configurations and additional sidewalk railings. A simple approximation was also proposed for the influence of web gap lateral deflection on web gap stress.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200538.pdf

Related Projects:
"Phase 3 - Rapid Assessment of and Decision-Making Strategies for Distortional Fatigue in Mult-Girder Steel Bridges" Contract 81655 WO 14
"Phase 2 - Analysis Tools and Rapid Screening Data for Distortional Fatigue in Steel Bridge Girders" Contract 74708 WO 177
"Remote Monitoring of Distortional Fatigue in Multi-Girder Steel Bridges" Contract 74708 WO 94
"Monitoring and Assessment Program for (Mn/DOT Bridge No. 79000) at Wabasha over the Mississippi River Phase I." Contract 74708 WO 18

Report #2005-39

Principal Investigator:
David Noyce, University of Wisconsin—Madison

Technical Liaison:
Paul Stine, Mn/DOT, Office of State Aid

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
84374

Contract Period:
11/1/2003 to 11/30/2005

Funding:
$18,970 STIP
$20,000 LRRB

Program:
CY 2003 LRRB INV 786 and Mn/DOT Transportation Research Program

The Safety and Cost-Effectiveness of Bridge-Approach Guardrail For County State-Aid (CSAH) Bridges in Minnesota

Description:
The primary objective of this research was to determine the average daily traffic (ADT) at which the benefit/cost ratio for the installation of approach guardrail at county-state-aid (CSAH) bridges in Minnesota becomes greater than 1.0.

Conclusions:
Bridge-approach guardrail provides protection for vehicles from collision with bridge components, such as the blunt end of the bridge rail or abutment, and other types of run-off-the-road collisions. The primary objective of this research was to determine the ADT at which the benefit/cost ratio for the installation of approach guardrail at CSAH bridges in Minnesota becomes greater than 1.0. A survey of state transportation agencies found that 26 of 35 responding agencies have policies or guidelines requiring placement of approach guardrail on any bridge if the bridge was built using state funds. Results of the research analyses showed that bridge-approach guardrail was effective at reducing the severity of run-off-the-road crashes occurring on the approach or departure to CSAH bridges. Fatalities and A-injury crashes accounted for only 6 percent of the crashes occurring at bridges with approach guardrail compared to 28.5 percent at bridges without approach guardrail. The subsequent benefit/cost analysis showed that bridge-approach guardrail is cost-effective
(i.e., B/C > 1) for CSAH bridges with ADT greater than or equal to 300 vehicles per day (vpd). Overall, approach guardrail has a benefit/cost ratio of approximately 3.5 to 5.5. The researchers recommended that the ADT threshold for approach guardrail on CSAH bridges be set at 400 vpd, which is consistent with previous Mn/DOT standards and AASHTO low-volume local road guidelines. Approach guardrail should be considered on a case-by-case basis for bridges with ADT between 150 and 400 vpd, especially those between 300 and 400 vpd. Placement of approach guardrail at bridges with ADT less than 150 vpd is not cost-effective in most cases.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At: http://www.lrrb.gen.mn.us/pdf/200539.pdf

Report #2005-40

Principal Investigator:
Nikolaos Papanikolopoulos, University of Minnesota

Technical Liaison:
Ray Starr, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 42

Contract Period:
11/1/2003
to 10/30/2005

Funding:
$72,000 Guidestar
$18,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Development of a Tracking-based Monitoring and Data Collection System

Description:
This report presents solutions to the problem of reliable target detection and tracking in unconstrained outdoor environments as they pertain to vision-based data collection at traffic intersections.

Conclusions:
This report presented a data collection system for outdoor traffic intersections using a single vision-based camera system. We proposed an algorithm for obtaining good spatial resolution and minimizing occlusions through an optimization-based camera-placement algorithm. A camera calibration algorithm along with the camera-calibration-guided user interface tool was also presented. Finally, we presented a computationally simple data collection system using a multiple cue-based tracker. Extensive experimental analysis of the system was performed using three different outdoor traffic intersections.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200540.pdf

Report #2005-41

Principal Investigator:
Nicholas Ward, University of Minnesota

Co-Principal Investigator:
Michael Rakauskas, University of Minnesota

Technical Liaison:
Todd Kramascz, Mn/DOT, Office of Traffic, Security and Operations—RTMC (Traffic Operations)

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 41

Contract Period:
11/1/2003 to 10/31/2005

Funding:
$96,000 Guidestar
$24,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Driving Performance During Cell Phone Conversations and Common In-Vehicle Tasks While Sober and Drunk

Description:
This study compared driver performance while conversing on a hands-free cell phone to conditions of operating common in-vehicle controls (e.g., radio, fan, air conditioning) and alcohol intoxication (BAC 0.08).

Conclusions:
The crash risk associated with cell phone use while driving is a contentious issue. Many states are introducing Advanced Traveler Information Systems (ATIS) that may be accessed with cell phones while driving (e.g. 511 Traveler Information Services). In these contexts, there is a need for relevant research to determine the risk of cell phone use. This study compared driver performance while conversing on a hands-free cell phone to conditions of operating common in-vehicle controls (e.g., radio, fan, air conditioning) and alcohol intoxication (BAC 0.08). In addition, the study examined the combined effects of being distracted and being intoxicated given that there may be a higher risk of a crash if the driver engages in a combination of risk factors. During simulated traffic scenarios, resource allocation was assessed through behavioral measures and an event-related potential (ERP) novelty oddball paradigm.

The results indicated that during a car following scenario, drivers engaged in the conversations or completing in-vehicle tasks were more impaired than drivers that were not involved in any distraction task. Indeed, both the cell phone and in-vehicle sources of distraction were generally more impairing than intoxication at the legal limit. These results will be used in a follow up study in order to compare the effects on attention of driving and using 511 to distraction from these tested distractions.

Implementation:
Project was featured in an April 27, 2005 article in the St. Pioneer Press titled "When is a Sober Driver as Scary as a Drunk? When Distracted by Talking on Cell Phone or Fiddling With Radio, U Researchers Find".

No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At: http://www.lrrb.gen.mn.us/pdf/200541.pdf

Report #2005-42

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
Marc Briese, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 39

Contract Period:
1/20/2003 to 10/30/2005

Funding:
$48,000 Guidestar
$12,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Identification of Causal Factors and Potential Countermeasures for Fatal Rural Crashes

Description:
The most frequently identified causal factors were driver inexperience and failure to properly use restraints, while provision of rumble strips, improvements to roadsides or cross-slopes, and provision of guardrails or barriers were the most frequently-cited countermeasures.

Conclusions:
This project was divided into three phases. In phase 1 ten fatal run-off-road crashes were reconstructed from crash scene diagrams and investigation reports. We found evidence of excessive speed in five of these, and a failure to properly use seatbelts eight of the ten. For seven of these we found that barriers complying with Test Level 3 of NCHRP Report 350 would probably have stopped the crashing vehicle's encroachment. In phase 2 we developed a vehicle trajectory simulation model and used it reconstruct five fatal median-crossing crashes. We found clear evidence of excessive speed in one of these, and in three of the five the encroaching vehicle would probably have been restrained by Test Level 3-compliant barriers.

In phase 3 five teams of traffic safety professionals reviewed accident reports from a sample of fatal rural crashes, with the aim of identifying possible causal factors and potential countermeasures. The most frequently identified causal factors were driver inexperience and failure to properly use restraints, while provision of rumble strips, improvements to roadsides or cross-slopes, and provision of guardrails or barriers were the most frequently-cited countermeasures.

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200542.pdf

Report #2005-43

Principal Investigator:
Dave Hein, ERES Consultants

Co-Principal Investigator:
Leslie Titus-Glover, ERES Consultants

Technical Liaison:
Tom Mathisen, City of Crystal

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract Number:
86953

Contract Period:
11/15/2004
to 12/30/2005

Funding:
$88,878.79
LRRB

Program:
CY 2004
LRRB
INV 821

Impacts of Increasing Roadway Construction Standards on the Life-Cycle Costs of Local Residential Streets

Description:

Residential street maintenance cost is expensive due to harsh climate conditions and a rise in traffic. Mn/DOT is doing research to see which option is better: The regular 5-to- 7 ton design or 9-to 10 design.

Conclusions:

With increasing traffic being carried by residential streets, combined with the negative effects of climate on pavement material durability and strength and damage due to frequent cutting and patching of the roadway pavement to allow for the placement of utilities, residential streets are requiring more frequent, extensive, and costly maintenance and rehabilitation (M&R). Also, the pavement design life is significantly reduced.

The increased cost of M&R and eventual reconstruction is an added burden on already limited city budgets. To rectify this situation, city managers and engineers are analyzing the difference in cost over a 30 year life-cycle for 9- to 10-ton design standard compared to a 5- to 7-ton design standard. Adopting a more significant pavement structure does, however, have significant cost implications, as the initial cost of the pavement is expected to rise significantly. This increase in cost is expected to be offset by a significant decrease in M&R costs and an increase in pavement life that will delay eventual reconstruction.

Mn/DOT, on behalf of the LRRB, initiated this study to evaluate the impact of enhancing roadway construction standards to accommodate greater axle loads on local residential streets in Minnesota cities on life-cycle costs. The primary focus of this study was to compare the current residential roadway construction and maintenance life-cycle costs (5- to 7-ton based on construction standards) to the lifecycle costs of residential roadways constructed with 9- to 10-ton standards.

Implementation:

No Implementation plan was written.

Implementation Outcome:

No Close-out memo was written.

Report Located At:

http://www.lrrb.gen.mn.us/pdf/200543.pdf

Report #2005-44

Principal Investigator:
Brian Scott, SRF Consulting Group, Inc.

Technical Liaison:
Mike Adams, Federal Highway Administration

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Number:
83107

Contract Period:
6/1/2002 to 1/31/2005

Funding:
$205,571.50 Pooled Fund

Program:
Pooled Fund

The Aurora Consortium - Laboratory and Field Studies of Pavement Temperature Sensors

Description:
This report presents the methods, results and conclusions of the Laboratory and field Studies of Pavement Temperature Sensors evaluation sponsored by the Aurora Consortium. The Aurora Consortium is a joint program of collaborative research, evaluation and deployment of advanced technologies. The objective of this study was to measure and compare the surface temperature reporting performances of various competing models of pavement temperature sensors in varying environmental conditions.

Conclusions:
The Aurora Consortium is a joint program of collaborative research, evaluation and deployment of advanced technologies for detailed road weather monitoring and forecasting. Members seek to implement advanced road and weather information systems that fully integrate state-of-the-art roadway and weather forecasting technologies.

Many agencies use various models of in-ground and mobile sensors to measure pavement temperature. However, little documentation exists on the accuracy of the various sensors, and there is no standard methodology for sensor testing. The data and conclusions drawn from this study are published so that Aurora members and others will have additional information to assist in their implementation and procurement decisions. Additionally, results from this study will be used by the NCHRP to develop testing and calibration standards for pavement sensors.

The objective of this project was to conduct both laboratory and field studies of various competing models of in-pavement (contact) and mobile (non-contact) type pavement temperature sensors and compare them to baseline readings in order to quantify the surface temperature measurement performance of each sensor and sensor type. The laboratory tests were conducted at the Braun Intertec laboratory in Bloomington, Minnesota. Field tests were conducted at Mn/DOT's MnROAD facility near Monticello, Minnesota.

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200544.pdf

Report #2005-45

Principal Investigator:
Tom Burnham, Mn/DOT, Office of Materials

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract Number:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
MnROAD Project

Forensic Investigation Report for MnROAD Ultra-thin Whitetopping Test Cells 93, 94 and 95

Description:
The main focus of this report is to describe the forensic investigation procedure carried out, and to summarize the findings from the investigation. The forensic investigation provided clear evidence that debonding of the ultra-thin whitetopping (UTW) from the hot-mix asphalt layer leads to cracking, and eventually, significant surface distress.

Conclusions:
Three instrumented UTW pavement test sections were constructed in 1997 at the MnROAD. The sections were installed on the interstate highway portion of MnROAD to accelerate the traffic loadings compared to typical applications of UTW. By spring 2004, significant deterioration of the sections had occurred. Prior to replacement of the three test sections in fall 2004, a forensic investigation of the distresses was carried out. The focus of this report was to describe the forensic investigation procedures carried out, and to summarize findings from the investigation. The investigation revealed that the performance of ultra-thin whitetopping test cells at the MnROAD project was related to traffic volume, wheel placement, and layer bonding. Distresses were more frequent and severe in the higher-volume driving lane. Panel sizes that place wheelpaths near the edges of UTW slabs resulted in accelerated distress and poor performance. Bonding of UTW to the underlying asphalt layer was essential for long-term performance. Reflective cracking occurs in bonded concrete overlays for thicknesses less than 5 inches (over 6 inch minimum asphalt layer). Large polyolefin fibers did provide some benefit to crack containment in UTW, but added significant cost to the concrete mix.

Implementation:
Presentations made at “Lessons Learned at MnROAD”.

No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200545.pdf

Report #2005-46

Principal Investigator:
Nancy Ehlke, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 58

Contract Period:
11/11/2002 to 12/31/2005

Funding:
$105,094 STIP

Program:
Mn/DOT Transportation Research Program

Assessment of AFLP-based Genetic Variation in Three Native Plant Species Across the State of Minnesota

Description:
This research analyzed the genetic diversity of three native species across their range in Minnesota.

Conclusions:
Analysis of genetic diversity and population differentiation determines how diverse natural populations are and how closely related they are to one another, which can provide clues concerning adaptation for restoration projects. This research analyzed the genetic diversity of three native species across their range in Minnesota. Using Amplified Fragment Length Polymorphisms, the genetic diversities of three species-prairie cordgrass (Spartina pectinata), purple prairie clover (Dalea purpurea), and spotted Joe-pye weed (Eupatorium maculatum)-were examined. The diversity for all the species had more disjunct relationships rather than displaying geographic or ecological patterns. The genotypic variation may be due to ecotypic variation or to genetic drift as a result of habitat fragmentation. The species had Gst values, a measure of how much populations differ, that ranged from 0.18 up to 0.27, indicating clear population differentiation. Analysis of molecular variance results concurred. The natural populations of all these species showed moderate levels of genetic diversity. This information is helpful in ensuring adequate diversity in seed sources for restorations. Additional research on these populations by performing common garden and reciprocal transplantation experiments would be a useful supplementation to the molecular marker data. For restorations in Minnesota, the best option may be to use seed that is as close as possible.

Implementation:
No Implementation plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
The report is being held from publishing until it is published in a journal by the author.

Report #2005-47

Principal Investigator:
Henryk Stolarski, University of Minnesota

Technical Liaison:
Dave Johnson, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
73590 WO 185

Contract Period:
9/15/1995 to 9/27/2000

Funding:
$468,670
Pooled Fund

Program:
Pooled Fund
SPR-2(179)

Load Testing of Instrumented Pavement Sections

Description:
The Load Testing of Instrumented Pavement Sections project included strain measurements from a variety of vehicle loads, including single, tandem, and tridem axles, tire pressures, tire types, various vehicle speeds, and several different seasons.

Conclusions:
This report summarizes and references seven previously written reports developed from this project. The objective of this project was to use the field-measured strains from a number of MnROAD cells to develop mechanistically based load equivalency factors (LEF). The load equivalency factors commonly in use were developed from the AASHTO Road Test conducted in the late 1950s at Ottawa, Illinois. The AASHTO-based LEF represented the pavement behavior at the Road Test and might not reflect conditions in other climates, other subgrade soils, pavement sections, traffic and so on. Several of the MnROAD project objectives related to the development of improved mechanistic models and the development of improved pavement design methods.

The Load Testing of Instrumented Pavement Sections project included strain measurements from a variety of vehicle loads, including single, tandem, and tridem axles, tire pressures, tire types, various vehicle speeds, and several different seasons. The testing and analysis resulted in the evaluation of various mechanistic models and the selection of WESLEA for flexible pavements and ISLAB2000 for rigid pavements. Many of the strain sensors, installed during construction in 1993 or 1994, no longer worked limiting the number of test cells available and the scope of the study. The LEF analysis for flexible pavements were based on only the tensile strain at the bottom of the asphalt, and were generally lower than the corresponding AASHTO factors. There were too few strain sensors available to conduct an LEF analysis on rigid pavements, however, during the selection of ISLAB2000, a number of relationships were developed that relate k-value, to other factors such as slab thickness, slab elastic modulus, and strain.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200547.pdf

Report #2005-48

Principal Investigator:
Panos Michalopoulos, University of Minnesota

Co-Principal Investigator:
John Hourdos, University of Minnesota

Technical Liaison:
Nick Thompson, Mn/DOT, Metropolitan District

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 96

Contract Period:
4/22/2004 to 11/30/2005

Funding:
$119,621 Guidestar
$29,905 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Evaluation and Improvement of the Stratified Ramp Metering Algorithm Through Microscopic Simulation - Phase IIb

Description:
The goal of this research is to develop a methodology for assisting in evaluating, improving and optimizing the new ramp metering strategy reliably and quickly prior to field deployment. This involves the two following specific objectives:
1.Identifying how the Stratified Ramp Metering algorithm compares and contrasts to the pre-shutdown ramp metering algorithm; and
2.Analyzing the sensitivity of Stratified Ramp metering algorithm to different incentives including the algorithm's own parameters in order to help fine-tuning, probe deficiency and propose improvements.

Conclusions:
A new ramp metering strategy implemented on the Twin Cities freeway system to reduce ramp waiting times was evaluated through microsimulation of freeway activity. The study compared
Stratified Ramp Metering strategy with the previous Zone Metering Strategy and with no control strategy.

Comparison with Zone, which was designed to favor freeway flow, showed the new strategy succeeded in greatly reducing ramp delays and lines. When compared to the results of no control strategy, it reduces freeway travel time, increases freeway speed, smoothes the flow of traffic, and reduces the number of stops.

However, travel time, fuel consumption and pollutant emissions are unpredictable under the newer system. Compared to no control strategy, such measures of effectiveness may improve or worsen depending on the freeway patterns and demand. Based on these findings, the researchers will seek improvements to the design of the Stratified Ramp Metering algorithm so as to factor in disruptive traffic patterns.

Implementation:
No Implementation Plan was written

Implementation Outcome:
No Close-out memo

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200548.pdf

Related Projects:
74708 WO 174 “Employment of the Traffic Management Laboratory (TRAMLAB) for Evaluating Ramp Control Strategies - Phase I”
81655 WO 94 “Streamlining of the Traffic Modeling Process for Implementation in the Twin Cities Freeway Network - Phase IIa”
81655 WO 176 “Employment of the Traffic Management Lab for the Evaluation and Improvement of Stratified Metering Algorithm: Phase III”

Report #2005-49A
#2005-49B

Principal Investigator:
John Nieber,
University of Minnesota

C0-Principal Investigator:
Robert Sykes,
University of Minnesota

Technical Liaison:
David Jessup,
City of Woodbury

Administrative Liaison:
Barb Loida,
Mn/DOT

Contract Number:
81655 WO 75

Contract Period:
5/20/2003
to 2/28/2006

Funding:
$128,896
LRRB

Program:
CY 2003
LRRB
INV 799

Impact of Alternative Storm Water Management Approaches on Highway Infrastructure: Guide for Selection of Best Management Practices - Volume 1

and

Impact of Alternative Storm Water Management Approaches on Highway Infrastructure: Project Task Reports - Volume 2

Description:
To investigate the potential positive and negative impacts of alternative storm water measures on transportation infrastructure, and assess the level of acceptance of these alternative measures with decision makers.

Conclusions:
From the results of the first MnPAVE analysis, it can be observed that as subgrade soil water content increases and Mr. decreases, the fatigue and rutting lives predicted by MnPAVE decrease. On the other hand, from the results of the second MnPAVE analysis, it can be observed that as subgrade soil water content increases and Mr. decreases, the thickness of HMA and AggBase required by MnPAVE to maintain a 20 year design life increases .

Based on these two analyses using the MnPAVE software, it is possible to conclude that there is the potential for decreased pavement performance, in the form of reduced design life, if the subgrade soil water content is increased. A storm water BMP might increase the adjacent subgrade soil water content and, as a result, be responsible for the potential increase in the cost of maintenance since the road will cost more in order to overcome the limitations of the higher moisture content. However, no field data were collected within this study to allow the testing of this simulated result. Additional work will be necessary to further test this idea in the field.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200549A.pdf

Related Projects:
81655 WO 78 “Cost Effectiveness Analysis of Storm Water Runoff Best Management Practices” INV 800

Report #2005-50

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 102

Contract Period:
1/2/2004 to 12/31/2005

Funding:
$50,000 COPTRS

Program:
Mn/DOT Transportation Research Program

Tools for Predicting Usage and Benefits of Urban Bicycle Network Improvements

Description:
This project addresses four independent research questions analyzing the relationship between the behavior of bicyclists and the availability of cycling facilities in and around the Twin Cities metropolitan area.

Conclusions:
This report gives a brief overview of four related small research projects. The full papers resulting from the projects are included as appendices. The four projects were related by the theme of bicycling preferences and behavior with regard to bicycling facilities. The studies were also connected by the fact that they were all based on information from the Twin Cities of Minneapolis and St. Paul, Minnesota.
The four reports are:
• Effect of Trails on Cycling
• Value of Bicycle Facilities to Commuters
• Effect of Facilities on Commute Mode Share
• Cycling Behavior Near Facilities

Generally speaking, the results support the notion that people value bicycle facilities, in that they are willing to incur additional time costs in order to use higher quality facilities. The presence of facilities also appears to be associated with higher amounts of riding, although the precise nature of the impact is still unclear.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200.pdf

Related Project:
81655 WO 54 “Economic Benefits of Bicycling in Minnesota”

2004 List of Completed Projects

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Report #2004-02

Principal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
Scott Pierson, Mn/DOT, Office of Bridge

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 102

Contract Period:
January 1, 1999 to September 30, 2002

Funding:
$100,000 STIP

Program:
Mn/DOT Transportation Research Program

Repair of Fatigued Steel Bridge Girders with Carbon Fiber Strips

Description: Investigation of a method of repairing fatigued steel bridge girders using carbon fiber reinforced polymer (CFRP) strips to prevent the propagation of cracks which could lead to failure of the bridge girders. Tests were conducted on full-scale cracked girders; the application of the CFRP strips to the steel girders resulted in significant strain reduction, except in the case of small cracks where it was difficult to clearly identify the benefits.

Conclusions:
In order to investigate the possibility of a rehabilitation method with bonded CFRP strips, experimental tests and computational studies have been conducted. Because little research has been conducted on the use of CFRP strips for rehabilitation of steel members, it was required to design a new test setup and specimen to determine the effective bond length of a CFRP strip bonded onto a steel flange. Once the effective bond length was determined, fatigued steel girders were rehabilitated with bonded CFRP strips in order to investigate the effect of the rehabilitation method on crack growth. In this chapter, major findings from this research will be presented. A recommended rehabilitation procedure is proposed in Appendix B.

Implementation:
The results of this project would provide a strong basis for future research. If a method can be found to use carbon fiber strips to repair steel girders, the benefits to Mn/DOT would be large. Current repair measures require accessing the top flange from either the top of the girder or from the bottom. To access from the top, sections of the concrete deck need to be removed which requires lane closures. This is costly and raises safety issues for maintenance workers and the motoring public. Accessing from the bottom to install the angles is heavy work and the hole drilling is very time consuming. If a repair method utilizing fiber strips is developed, it is conceivable that they could be installed in a mater of hours for a fraction of the cost of either of the other repair methods. In addition, the safety risk to workers and motoring public would be minimized.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200402.pdf

Report #2004-03

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Mark Filip, Metropolitan Council

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 188

Contract Period:
December18, 2000 to September 30, 2003

Funding:
$40,000 COPTRS

Program:
Mn/DOT Transportation Research Program

Transportation-Related Impacts of Different Regional Land-Use Scenarios

Description:
Discussion of regional land-use patterns impacting travel behavior and the resulting transportation costs and benefits. Six hypothetical future regional land-use scenarios for the Twin Cities region are defined. Traffic patterns resulting from each scenario are used to describe the resulting congestion, air pollution, and accessibility to jobs.

Conclusions:
The general question that this research has attempted to answer is the following: are there ways of accommodating growth in an urban region that are significantly better than other methods in terms of achieving transportation goals? The results indicate that the current conventional wisdom that compact development is better is at best an oversimplification. Certain types of compact development appear to be better for certain goals, or for certain places, while being worse for other goals or other places.

The basic finding that there are tradeoffs inherent in different styles of land development, reasonable as it may seem on the surface, represents a degree of subtlety that seems to be missing from much of the debate on this issue, where the various schools of thought tend to be represented as either "good" or "bad." Part of the problem arises out of the tendency in the literature to examine only a single issue at a time: how can transit use, or walking, be increased? How can fuel consumption, or congestion be decreased? The notion of tradeoffs is hard to accommodate in this kind of single-issue analysis.

Implementation:
No direct, tangible impacts were identified by the Principal Investigator or Mn/DOT Technical Liaison as a result of this research other than the knowledge gained.

Implementation Outcome: Knowledge Gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200403.pdf

Report #2004-04

Principal Investigator:
Thomas Stinson, University of Minnesota and Barry Ryan, University of Minnesota

Technical Liaison:
Kennth Buckeye, Mn/DOT and Richard West, Otter Tail County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
81655 WO 11

Contract Period:
September 17, 2001 to December 31, 2003

Funding:
$199,996, LRRB

Program:
CY2001 LRRB INV 777

Paying for Minnesota Roads: A Tax Policy Assessment

Description:
Travel on low volume roads in Minnesota costs more than the spending average of 5 cents per vehicle miles of travel (VMT). Substituting travel-dependent taxes for fixed or hidden charges could improve the tax system efficiency, and potentially distribute the road tax burden more fairly.

Conclusions:
1) Road networks and road users vary widely. 2) State and local roads generate 52 billion vehicle miles of travel a year. 3) Minnesota's vehicle fleet is large and growing. 4) Roads are a significant public expenditure. 5) Low-volume networks are at VMT cost disadvantage. 6) State road aid helps equalize the local road effort. 7) State level taxes share about one-third of local road costs. 8) Property taxes do not cover the cost of local road service. 9) Minnesota has three statewide road taxes. 10) Road taxes should signal road users about the true cost of service.
11) Minnesota households *on average* pay $600 per household vehicle a year in road-related taxes. 12) Roads cost *average* household between 1.5% and 2% of income. 13) Travel-dependent taxes can send different price signals. 14) Alternative tax strategies may have small household budget impact.

Implementation:
The research has provided a baseline set of facts that will help people (legislators, media, general public) better understand the implications of various road taxing policies. It also provides an order of magnitude and information on what is reasonable per household. The Principal Investigators are currently working on two related projects: 1) Inv. 814 Implications of State Aid Cuts for Local Road Funding and 2) Adequacy of Future Road Funding.

Implementation Outcome:
Knowledge Gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200404.pdf

Report #2004-05

Principal Investigator:
Theresa Adams, University of Wisconsin-Madison

Technical Liaison:
Jim Pierce, Mn/DOT, Office of Bridge

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
80318

Contract Period:
January 8, 2001 to December 31, 2003

Funding:
$139,116 STIP

Program:
Mn/DOT Transportation Research Program

Element Unit and Failure Costs and Functional Improvement Costs For Use in the Mn/DOT Pontis Bridge Management System

Description:
This research demonstrates a data-based strategy for integrating elemental unit costs associated with bridge maintenance and replacement (currently collected and managed by Mn/DOT's Work Management System) into the Pontis Bridge Management System.

Conclusions:
The primary and most significant benefit of this research is that it provides Mn/DOT with essential data for identifying bridge maintenance polices that minimizes total long-term costs.

The research provides Mn/DOT with essential data for running the Pontis Preservation Maintenance and Functional Improvement models. Maintenance costs from the Mn/DOT Estimating Unit and WMS warehouse are now the input used by Pontis to calculate preservation maintenance policies and to evaluate functional improvement projects. By using costs and functional improvement parameters that are specific for Minnesota, the results of the Pontis models can be more confidently interpreted to influence bridge management decision-making. A secondary benefit of the research is that Mn/DOT now has a convenient mechanism for keeping some maintenance costs up-to-date. Periodically running the *Pontis Cost Interface* program ensures that recent costs in the Mn/DOT Bridge Maintenance table are used to update the expert elicitation tables.

Implementation:
Bridge office personnel have carried out all actions outlined in the implementation plan. Once the amount of WMS data is sufficient for accurate calculations from Pontis, the system can be evaluated on the basis of personnel time saved. Long-term, measures may be possible based on more accurate interpretation of Pontis results used in decision making.

The primary and most significant benefit of the research and implementation is that is gives Mn/DOT essential data for identifying bridge maintenance policies that minimize total long-term costs. By using costs and functional parameters that are specific to Minnesota, the results of Pontis models can be more confidently interpreted to influence bridge maintenance decisions.

Implementation Outcome: Change without measure

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200405.pdf

Report #2004-06

Principal Investigator:
Lawrence Zanko, UMD, Natural Resources Research Institute

Technical Liaison:
Alan Goodman, Lake County Highway Department Engineer

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 169

Contract Period:
July 25, 2000 to December 31, 2003

Funding:
$126,000 LRRB

Program:
CY2000 LRRB INV758

Properties and Aggregate Potential of Coarse Taconite Tailings: an Evaluation of Five Minnesota Taconite Operations

Description: This report evaluates the technical and economic viability of using coarse taconite tailings for construction aggregate purposes by analyzing the results of tests run on their physical, geological, mineralogical, and chemical properties as well as doing a market analysis.

Conclusions:
This report stands as a major technical reference for coarse taconite tailings. It provides well-documented baseline data that can be used by the taconite companies, transportation officials, highway engineers, contractors, aggregate producers, and the public for making rational decisions about the use of taconite mining byproducts like coarse tailings to supplement current and future aggregate requirements, not only on the Iron Range, but in other areas of the state, and beyond. Furthermore, making greater use of materials that have long been considered "waste" byproducts makes environmental sense because it maximizes the use of a resource that has already been mined and crushed, and could reduce the pressure to expand existing (or develop new) "natural" aggregate sources.

Implementation:
The 2003/2005 RIC implementation contract with SRF Consulting included a task for Taconite Tailing Education and Communication Tools. The brochure is expected to be completed by April 2005 and will be distributed to local engineers, district state aid engineers and technical advisory panel members including the P.I., a representative from Minnesota Asphalt Pavers Association, Cleveland Cliffs (USS) and a member of the Aggregate Ready Mix Association.

An implementation plan was also developed under a contract with the Center for Transportation Studies, with input from the researcher and technical liaison, that would dovetail the RIC task described above that was just beginning. The plan called for a) a compilation and coordination of ongoing research and implementation activities being conducted by a variety of agencies and practitioners, b) a mechanism for monitoring and updating relevant information related to the use of taconite tailings in road construction, and c) a champion to educate, inform and market it's use. Attachment A shows a list of ongoing activities/contacts that was developed for the implementation plan. The plan was submitted for funding ($31,000) to the RIC in September 2004, but was not approved.

Implementation Outcome: Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200406.pdf

Report #2004-07

Principal Investigator:
Max Donath, Kathleen Harder, Craig Shankwitz, Nicholas Ward, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 160

Contract Period:
October 1, 1999 to September 30, 2003

Funding:
$3,025,768
Guidestar

Program:
ITS

Evaluation Report Volume 1: System Performance and Human Factors Intelligent Vehicle Initiative Specialty Vehicle Field Operational Test

Description:
Human factors and benefit cost analyses are reported for the Driver Assistive System (DAS). The DAS improves safety for specialty vehicle operators by providing necessary cues for lane keeping and collision avoidance normally unavailable during poor visibility conditions.

Conclusions:
The goal of the FOT was to determine whether, by using the DAS, the performance of the specialty vehicle operators was enhanced in conditions of very limited visibility. Driving performance data was to have been collected under the following visibility conditions: (1) clear visibility; (2) very limited visibility with the DAS *On*; and (3) very limited visibility with the DAS *Off*. Vast amounts of driving performance data were collected during the FOT. But, all these driving performance data fell into the first visibility category. No driving performance data were collected at any time during the FOT when there was very limited visibility (i.e., visibility levels below 100 meters or in the 100- to 199-meter range). Therefore, no driving performance data were collected in conditions of very limited visibility with the DAS *On*, or in conditions of very limited visibility with the DAS *Off*. This means that *comparative statistical analysis* could not be used to test the FOT hypotheses. Because no data was collected with the operators driving in conditions of very limited visibility with the DAS *On*, or in conditions of very limited visibility with the DAS *Off*, no statistically relevant conclusions about the effect of using the full Driver Assistive System on (1) vehicle speed, (2) vehicle trajectory instability, (3) collision avoidance reaction time, or (4) lane departure duration can be drawn. However, with regard to *lane departure duration*, it is possible to conduct a comparative statistical analysis to test a different *subsidiary* hypothesis. Often the operators drove with the DAS switched *On* but with the Head-Up Display pushed up out of the way; when this happened the operators could *not* receive the visual lane departure warning although they did receive auditory and haptic lane departure warnings.

Implementation:
This Driver Assist System implementation plan has two phases with the plan for Phase II to be developed near the end of Phase I. Phase I focuses on application of the DAS to snowplows. Phase II will focus on application to public us systems. Ambulance and patrol vehicle DAS implementation is deferred to a future time.

Implementation Outcome:
No Close-out memo was written.

Report Located At: http://www.lrrb.gen.mn.us/pdf/200407.pdf

Report #2004-08

Principal Investigator:
Max Donath, Kathleen Harder, Craig Shankwitz, Nicholas Ward, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 160

Contract Period:
October 1, 1999 to September 30, 2003

Funding:
$3,025,768
Guidestar

Program:
ITS

Evaluation Report Volume 2: Benefit Analysis Intelligent Vehicle Initiative Specialty Vehicle Field Operational Test

(US DOT IVI Specialty Vehicle Field Operational Test)

Description:
Assessment report on the potential benefits of the Driver Assistive System (DAS) for winter maintenance activities, the potential market for DAS, and the commercial viability of DAS. Expected benefits of DAS include reduction in travel times, less disruption to travel behavior and improved safety for the traveling public during winter weather events.

Conclusions:
Perhaps the most important insight gained through this study is how a DAS would be perceived, valued, and utilized by winter maintenance personnel. Differences in the perception of DAS can be attributed, in part, to the visibility conditions and traffic characteristics of the regions being maintained. In regions with higher traffic volumes and frequent periods of low visibility, snowplow operations are rarely halted due to visibility. In these regions, the DAS would be used to improve the efficiency of winter maintenance activities as well as the safety of the snowplow operators. In regions with frequent low visibility and lower traffic volumes, DAS would be used when assisting public safety agencies with emergency response. It would not necessarily change winter maintenance operations. In regions where low visibility is infrequent, DAS is not considered high priority, would be deployed on a limited basis, and purchase decisions would be very sensitive to unit costs.
The regions that are most likely affected by low visibility during winter maintenance activities are illustrated in Figure 5.3. Maintenance engineers and supervisors that were willing to project a price at which the technology would be considered an attractive option, suggested, on average, $10,000 per vehicle. In addition to considering the potential demand and the projected price point of the system, prospective system developers/manufacturers will also judge the market viability of DAS based on the system's accuracy, durability/reliability, and production costs.

Implementation:
This Driver Assist System implementation plan has two phases with the plan for Phase II to be developed near the end of Phase I. Phase I focuses on application of the DAS to snowplows. Phase II will focus on application to public us systems. Ambulance and patrol vehicle DAS implementation is deferred to a future time.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200408.pdf

Report #2004-09

Principal Investigator:
Max Donath, Kathleen Harder, Craig Shankwitz, Nicholas Ward, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 160

Contract Period:
October 1, 1999 to September 30, 2003

Funding:
$3,025,768
Guidestar

Program:
ITS

System Performance and Human Factors Evaluation of the Driving Assistive System (DAS) - Special Vehicle Field Operational Test – IVI

Description:
This study attempted to determine the usefulness of the Driver Assistive System (DAS) in the context of plowing roads during low-visibility conditions.

Conclusions:
Overall, it seems that the DAS is beneficial for those in situations warranting low cost visibility enhancement solutions, with further cost benefits likely as technology becomes more common and affordable. Areas experiencing high turnover, and thus large numbers of drivers inexperienced with particular routes, may also benefit from DGPS technology utilizing extensive digital maps. With some adjustments and through further testing of the current implementation, the DAS design will move closer towards these aspirations by making changes not only in how the system functions but also how it is implemented.

Implementation:
This Driver Assist System implementation plan has two phases with the plan for Phase II to be developed near the end of Phase I. Phase I focuses on application of the DAS to snowplows. Phase II will focus on application to public us systems. Ambulance and patrol vehicle DAS implementation is deferred to a future time.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200409.pdf

Report #2004-10

Principal Investigator:
Frank Douma, Richard Bolan, University of Minnesota

Tom Horan, Claremont Graduate School

Milda Hedblom

Technical Liaison:
Kenneth Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 5

Contract Period:
October 29, 2001 to March 31, 2004

Funding:
$85,000 STIP
$340,000 Guidestar

Program:
FY2001 Guidestar Program and Mn/DOT Transportation Research Program

Telecommunications for Sustainable Transportation

Description:
This report investigates how advances in telecommunications-based technologies could aid in making transportation more sustainable. The effects of telecommunications on work and shopping trips, improvements in transit through new technology, and improvement in transportation system safety in rural areas through wireless telecommunications are discussed. More research on interorganizational process is needed.

Conclusions:
In terms of the original objectives of this report, it can be concluded that GPS has made a significant contribution to the DARTS system. GPS has aided in making DARTS a more
responsive and reliable service. It has stabilized costs. Our examination covered too short a period to do more than speculate about as yet unrealized benefits. Yet, the analysis provides us
with a considerably improved picture of the potentials and limitations of on-demand paratransit services.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200410.pdf

Related Projects:
81655 WO 45 “Using ITS to Better Serve Diverse Populations”
81655 WO 99 “Developing ITS to Serve Diverse Populations”

Report #2004-11

Principal Investigator:
David Biesboer, University of Minnesota

Technical Liaison:
Dwayne Stunlund, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 198

Contract Period:
March 19, 2001 to August 31, 2003

Funding:
$82,770 LRRB

Program:
CY2001 LRRB INV 776

Improving the Design of Roadside Ditches to Decrease Transportation Related Surface Water Pollution

Description:
Properly designed strips of vegetation and swales that include peat and rock check dams can reduce the level of pollutants in stormwater runoff from road surfaces.

Conclusions:
This model vegetated ditch and check dam were found to reduce pollution in the swale by as much as 54 percent. Phosphorus carried in stormwater is approximately 50 percent soluble and 50 percent affixed to sediment (Finley and Young 1993). Thus, if sediment can be efficiently trapped by a check dam system, 50 percent of the phosphorus load can be removed from stormwater. The average removal efficiency of TSS with this check dam was 52 percent. Clearly, the removal rates for phosphorus and TSS with the addition of the check dam in a vegetated swale are significantly higher than without a check dam. The average Ortho-P EMC value prior to installation of the check dam was greater in the output than the input flume. Following the installation of the check dam, the average EMC value for Ortho-P was reduced by 30 percent. Heavy metal levels decreased with the installation of the check dam, which may offer insight into the ability of the peat check dam to further enhance the treatment of stormwater. This research is promising in that the installation of the check dam was effective in reducing pollutant levels for all storm events, even during early spring storms. The check dam was able to compensate for the lack of vegetation during these seasonal changes. The average pollutant removals for the storms following the installation of the check dam were 54 percent TP, 47 percent Ortho-P, and 52 percent TSS. All heavy metal levels were decreased after flowing through the check dam. The frequency with which the peat layer must be replaced, when subjected to various stormwater-loading rates, is still largely unknown. In this study, P removal was still excellent after one year. Heavier record stormwater loadings such as those in June and July 2002 may have resulted in a shorter life span of the check dam.

Implementation:
In spite of the additional research to be done and that the PCA criteria for total phosphate reduction is 60%, the findings from the research are significant and can be implemented immediately. Specifications and electronic drawings in Mn/DOT format for the check dams need to be developed for use in road plans.

Adding check dams to living bioretention ditches offers a low-cost option to designers for meeting the PCA requirements. As an alternative to building a pond, the savings can be as much as $50,000 in right-of-way costs alone. As a side benefit, implementing the results of peer-reviewed research and making improvements immediately will help road agencies foster trust with the MPCA.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200411.pdf

Related Project: 74708 WO 139 "Characteristics of Erosion Control Measures and Their Impact on Erosion"

Report #2004-12

Principal Investigator:
Max Donath, Kathleen Harder, Craig Shankwitz, Nicholas Ward, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 160

Contract Period:
October 1, 1999 to September 30, 2003

Funding:
$3,025,768
Guidestar

Program:
ITS

System Performance and Human Factors Evaluation of the Driving Assistive System (DAS): Supplemental Track Test Evaluation – IVI

Description:
Project study to assess the usefulness of the Driver Assistive System (DAS) in the context of driving snowplows in low-visibility conditions on a test track. The system was found to be useful; several design improvements to the system are suggested to maximize its effectiveness.

Conclusions:
This project is a study to determine the usefulness of the in context of driving in low-visibility conditions on a test track. In doing so, driving performance, driver workload, and system performance results were drawn from these low-visibility conditions. Performance while using the DAS was comparable to that of normal low-visibility conditions in terms of average speed and speed variability. The system also enabled drivers to maintain their lane position during low visibility as well as (and sometimes better than) during clear visibility conditions. However, drivers did exhibit more steering corrections and were less responsive to hazardous events while using the DAS and while transitioning to the 3M system. This indicates that it was more difficult for some drivers to maintain smooth and consistent control of the truck while using the DAS. Subjectively, drivers liked the system and felt there were benefits to using it when the situation warranted. They were supportive to see future iterations of the DAS, especially if they would be less bulky and provide them with more stable view of the road.

Implementation:
This DAS implementation plan has two phases with the plan for Phase II to be developed near the end of Phase I. Phase I focuses on application of the DAS to snowplows. Phase II will focus on application to public us systems. Ambulance and patrol vehicle DAS implementation is deferred to a future time.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200412.pdf

Report #2004-13

Principal Investigator:
Michael Wade, University of Minnesota

Technical Liaison:
Robert Weinholzer, Mn/DOT, Office of Traffic, Security, and Operations

Jason Alcott, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
81655 WO 25

Contract Period:
March 4, 2002 to June 30, 2004

Funding:
$60,706 STIP

Program:
FY2002 Mn/DOT Transportation Research Program

Deer Avoidance: The Assessment of Real World Enhanced Deer Signage in a Virtual Environment

Description:
The main objective of this research was to determine whether the prototype signs would modify driver behavior such that they decreased their speed.

Conclusions:
In summary, we found that the VE simulation was sufficient to motivate drivers to perform as they would in the real world with little atypical behavior due to the conditions of the testing protocol. Relative to the signage types, there was an overall decrease among the study participants' driving speed in the proximity of the active enhanced signage. We recorded a decrease in the variability between each successive exposure to the active sign condition. A greater overall average speed and variance was demonstrated with the standard signage. The enhanced signage in the "off" position produced speeds that were essentially the same as the standard sign condition.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.org/pdf/200413.pdf

Related Project:
"Deer/Vehicle Collisions"

Report #2004-14 and #2004-14G (User's Guide)

Principal Investigator:
David Biesboer, University of Minnesota

Miriam Diamond, University of Toronto

Technical Liaison:
Greg Busacker, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 110

Contract Period:
March 1, 1999 to February 27, 2004

Funding:
$300,000 STIP

Program:
Mn/DOT Transportation Research Program

Environmental Hazard Assessment For Transportation Related Chemicals: Development of a Decision Support Tool

Description:
Researchers from the University of Toronto have developed a computer-based, decision support tool to assess the risks of vehicle-emitted chemical contaminants, affecting wildlife in the Twin Cities urban areas, as well as a decision support tool to assess the risks to birds and mammals of chemical contaminants released by vehicles.

Conclusions:
With support from Mn/DOT, a decision support tool has been developed to assess the fate of and potential risk posed by two classes of chemical contaminants released to the Minneapolis/St. Paul environment from transportation activities. The decision support tool consists of a mathematical model that first estimates the likely fate or distribution of chemicals emitted from vehicles and then, from this distribution, estimates the potential exposure and risk to selected bird and mammal species. The geographic scope of the model is a 45 by 45 km2 area within which are the Minneapolis/St. Paul Twin Cities. This area is segmented into 81 geographic segments of 5 by 5 km2. Within each segment the model estimates the long-term likely distribution and ecotoxicological effects of semi-volatile organic compounds (e.g., polycyclic aromatic hydrocarbons) and metals (e.g., copper). The model is run on a personal computer platform within a Windows© environment.

This research contributes to method development for ERA. Model development, particularly of models that incorporate exposure and toxicity, is an area of research that has been highlighted as critical for improving the utility of ERAs (43). The ERA method presented here advances other multi-media risk models by its relevance to the transportation sector, its applicability to non-metabolizable and metabolizable organic contaminants and metals, its generality to aquatic and terrestrial receptors, and its incorporation of inhalation and juvenile dietary exposure route. Although MUM is tailored to transportation emissions in an urban environment, this method is applicable to other scenarios that involve multiple chemical stressors present at low chronic conditions in terrestrial and aquatic environments, where all routes of exposure are relevant to wildlife exposure.

Implementation:
The model is usable, but specific to the Minneapolis/St. Paul area. To use the model effectively will require some sophistication on the part of the user regarding models in general and their specific uses. People who would be interested include environmental planners (Mn/DOT, Minneapolis, St. Paul, other Minnesota State Agencies) and people interested in the distribution of persistent chemicals in the urban environment.

Implementation presents a benefit to the user because it presents a way of asking questions that one could not ask before this work was completed. So the model presents a new method of examining the steady-state distribution of chemicals in the environment. The model also evaluates potential ecological risk impacts by examining connections between average daily traffic (ADT) mobile sources and chemicals emitted by vehicles. The ecological risk assessment is developed at a screening-level that maximizes adverse risk to animal receptors in order to detect potential problems. The results do not indicate that an actual "problem" exists, rather that there is the potential for a problem to exist. Therefore, additional investigation or research would be required to validate the correct interpretations of model outputs.

Implementation Outcome:
No Close-out memo was written.

Reports Located At:
http://www.lrrb.gen.mn.us/pdf/200414.pdf
http://www.lrrb.gen.mn.us/pdf/200414G.pdf

Report #2004-15

Principal Investigator:
Dong Wang, University of Minnesota

Technical Liaison:
Ruth Roberson, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 29

Contract Period:
August 15, 2002 to March 1, 2004

Funding:
$5,000 STIP

Program:
Mn/DOT Transportation Research Program

MnROAD TDR Evaluation and Data Analysis

Description:
This project was to develop a new composition-based calibration between water content and apparent dielectric constant of the pavement materials for improving the time domain reflectometry (TDR).

Conclusions:
A composition-based calibration equation was developed for predicting water content using apparent dielectric constant, temperature, texture composition, and a geometric correction factor as input variables. Whereas the apparent dielectric constant can be measured with TDR, the temperature with thermocouples, the texture composition may be determined with particle size and mineral analyses. In theory, the geometric correction factor should be conservative or relatively constant for a given texture if the particle arrangement was similar. The test results provided a somewhat confirmation such as in the Staples soil where á ~ 1.7. In several instances, the model did not converge or the geometric factor was different when changing water content. The non-convergence and inconsistent á values were likely caused by the large scattering in the measured dielectric constant values, especially in the Subgrade material. Because of project limitations there was also no test made on the exact mineral composition of each textural class and no replication for the same water content-temperature-texture combinations. Therefore, data interpretation should be made with caution when applying the new calibration to make corrections in the MnROAD dataset water content calculations. More rigorous testing is needed that will likely provide a more concrete validation of the new composition-based and temperature compensated calibration method for the pavement materials.

Implementation:
Technical Liaison recommended closing this project out; no further implementation.

Implementation Outcome:
Change with no measures.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200415.pdf

Report #2004-16

Principal Investigator:
Gerald McCullough, University of Minnesota

David Anderson, CTS, University of Minnesota

Technical Liaison:
Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
74708 WO 130

Contract Period:
July 1, 1999 to September 30, 2000

Funding:
$48,644 STIP

Program:
Mn/DOT Transportation Research Program

On The Value of Minnesota's Road Network

Description:
The main goal of this study is to infer the benefits of road infrastructure by examining the relationship between the value of the road infrastructure and the output of the state's economy.

Conclusions:
The productivity of highway capital in Minnesota appears to be very high. Our main finding is that a one percent increase in the amount of highway capital will lead to a significant increase in the value of good and services produced in the state. While there are no other studies of the value of Minnesota's highway capital, this finding is consistent with the findings of researchers studying the productivity of highway capital in other regions. It should also be noted that our findings do not necessarily mean that all new highway investments will lead to gains in productivity. Differences in returns across projects mean that evaluating individual projects is critical, and only by investing in the best projects available can high returns be maintained.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200416.pdf

Report #2004-17A

Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Tom Burnham, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 131

Contract Period:
September 10,1999 to March 31, 2004

Funding:
$195,007 STIP

Program:
Mn/DOT Transportation Research Program

Performance Testing of Experimental Dowel Bar Retrofit Designs Part 1 - Initial Testing

Description:
Three innovated designs are presented and evaluated in regards to transferring pavement loads across joints and cracks. Relates to 2004-17B, Part 2 - Repeatability and Modified Designs.

Conclusions:
Three new and experimental dowel bar retrofit designs, that address the issues of high retrofit cost and corrosion susceptibility, were tested in an accelerated manner in order to determine the potential viability of their use for restoration of load transfer in PCC pavements. Innovations in the designs included the use of fiber reinforced polymer dowels, grouted stainless steel pipe dowels, and a change in the geometric configuration of the design. An evaluation of test results and recommendations, regarding the use of the designs for restoration of load transfer in PCC pavements, are presented. The performance of the innovative dowel bar designs (Slabs 2, 3 and 4) is evaluated in comparison with that for the standard design (Slab 1), which featured 1.5-in. diameter epoxycoated mild steel dowels with a 15-in. length, 3-in. clear cover and 12-in. spacing. Slab 1 demonstrated excellent performance in terms of large Load Transfer Efficiency (LTEs) (in excess of 90%) and small differential deflections (less than 2.5 mils) over the duration of the test (10.5 million cycles), which was continued beyond the standard duration of 6.7 million cycles. Test Slab 2, with fiber-reinforced polymer (FRP) dowels of the same size and configuration as the mild steel dowels used in the standard detail (Slab 1), exhibited the poorest performance in terms of smaller LTEs and larger differential deflections. However, the measured values for these parameters at the end of the test (6.7 million cycles) were still superior to the accepted limits (LTE > 70% and diff. deflect. < 5 mils). It is suggested that a larger diameter FRP dowel, in which the increase in diameter is used to compensate for the lower modulus of elasticity of the FRP material, may offer comparable performance to the standard dowel bar retrofit detail. Test Slab 3, with grouted, stainless steel dowel bars (1.66-in. diameter, 1/8-in. wall thickness, 18-in. length, 3-in. clear cover and 12-in. spacing), performed as well as Slab 1 during the first 10.5 million cycles of loading. This test was extended beyond the standard duration to 13.5 million cycles. Measurements taken in the last 1.5 million cycles of this extended duration exhibited rapid deterioration of performance, with LTEs that meet acceptable performance (LTE > 70%) but with differential deflections approaching the 5 mil limit. Test Slab 4, which was nominally identical to Slab 1 except that clear cover was reduced from 3 in. to 2 in., performed as well as Slab 1. This test was continued beyond the standard duration of 6.7 million cycles to 12.4 million cycles. The reduction in clear cover does not appear to have affected load transfer at the joint.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200417A.pdf

Related Project:
72272 WO 146 “Development of Accelerated Load Test Platform for Pavements (MinneALF)”

Report #2004-17B

Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Tom Burnham, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 131

Contract Period:
September 10,1999 to March 31, 2004

Funding:
$195,007 STIP

Program:
Mn/DOT Transportation Research Program

Performance Testing of Experimental Dowel Bar Retrofit Designs Part 2 - Repeatability and Modified Designs

Description:
Effective load transfer across Portland cement concrete pavement joints significantly decreases pavement deterioration. Takes a look at the benefits, as well as the areas of concern regarding the use of dowel bars for effective load transfer across a joint or crack. Relates to 2004-17A, Part 1 - Initial Testing.

Conclusions:
This research addresses the problems of dowel bar retrofit cost and dowel bar corrosion by evaluating innovative dowel bar retrofit designs. Accelerated load testing of retrofit dowel bar details was performed using mild-steel, epoxy coated dowels and fiber reinforced polymer (FRP) dowels. The designs tested include a replicate of a design tested by Odden [14] in the first part of this study, as well as two new designs that featured variations of the current standard dowel bar retrofit design in terms of dowel bar material, depth of placement, number of dowels used, and dowel diameter. Verification testing of previously tested details is also presented. The performance of the innovative dowel bar designs (Slabs 7, 9 and 10) is evaluated in comparison with that for Slab 8, which featured 1.5-in. diameter epoxy-coated mild steel dowels with a 15-in. length, 2-in. clear cover and 12-in. spacing. Slab 8, which represents the standard dowel bar retrofit design except for a reduced clear cover (2 inches instead of 3 inches), is also a replicate of Slab 5-6 in Phase 2A [14]. Slab 8 demonstrated excellent performance in terms of large LTEs (in excess of 90%) and small differential deflections (less than 3 mils) over the 6.7-million cycle duration of the test. Slab 8 also exhibited very similar performance to Slab 5-6 in Phase 2A, indicating that the Minne-ALF test stand is capable of producing repeatable measurements. The results of these two slabs also demonstrate that a reduction in clear cover from the 3 inches to 2 inches does not affect adversely the load transfer at the joint. Test Slabs 7 and 9 were nominally identical to each other, and they were similar to Slab 8, except that they featured only two dowels each instead of the standard three dowels used in Slab 8. Slabs 7 and 9, which generated very similar performance results, exhibited the poorest performance in terms of larger differential deflections. At the end of these tests (6 million cycles), the measured values for LTE were slightly larger than 90%, which is well above the acceptable limit of 70%. However, differential deflections by the end of the tests for both of these slabs were approximately twice as large as the acceptable limit of 5 mils. Test Slab 10 utilized fiber-reinforced polymer (FRP) dowels of a larger diameter (1.75 inches) than is used for the standard dowel bar retrofit design (1.5 inches). The increase in dowel diameter was intended to improve the measured performance of Slab 2 in Phase 2A, which had the smallest LTEs and largest differential deflections of all test slabs in that series of tests. The increased diameter enabled Slab 10 to perform as well as Slab 8 in Phase 2B. Measured LTEs were larger than 90% and measured differential deflections were less than 3 mils for the 6.7-million cycle duration of the test of this slab. These results, taken in conjunction with those documented by Odden in Phase 2A [14], strongly suggest that a retrofit design featuring three 2-inch diameter FRP dowels with at least 2 in. of clear cover should match the performance of the standard design (Slab 1 in Phase 2A). Testing of that configuration is strongly recommended.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200417B.pdf

Related Project:
72272 WO 146 “Development of Accelerated Load Test Platform for Pavements (MinneALF)”

Report #2004-18

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Technical Liaison:
Lou Tasa, State Aid, District 2

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
81424

Contract Period:
March 15, 2001 to February 27, 2004

Funding:
$79,000 + $9,140 duplication
LRRB

Program:
CY2001-2002
LRRB/RIC
INV 645

Tool Kit for a Career in Civil Engineering

Description:
This CD-ROM kit contains a video, an FAQ document, a PowerPoint presentation and a brochure, all containing information on careers in civil engineering. The kit is especially directed toward high school students and was designed for use in school presentations on how to pursue careers in civil engineering.

Conclusions:
This tool kit was designed for use in school presentations, and contains information for high school students on how to pursue a career as a civil engineer or civil engineering technician. The kit contains a video, an FAQ document, a PowerPoint presentation and a brochure. The video and PowerPoint presentation give an overview of how to prepare for a civil engineering career while in high school, and list several schools in the region that offer civil engineering or civil engineering technician degrees. The FAQ document aids in answering students' questions, and the brochure may be disseminated at high schools or career fairs. This project addresses the future workforce shortage in civil engineering by presenting civil engineering careers as meaningful and satisfying and offering good job opportunities and salaries.

Implementation:
A survey was conducted a year after the initial Tool Kit was mailed out. At least 1,406 people heard a presentation. Another survey will be sent out to gather opinions after two years from the initial Tool Kit release.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.org/CE Toolkit/

Report #2004-19

Principal Investigator:
Julie Vandenbossche

Technical Liaison:
None

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
N/A

Contract Period:
N/A

Funding:
$30,000 LRRB

Program:
CY1999 LRRB
INV 748

INV 645:
Implementation of Research Findings (2003-2005)

RIC Task 4

The Construction and Performance of Ultra-Thin Whitetopping Intersections on US-169

Description:
Whitetopping tests at three different sections along US-169 at Elk River show distinctive cracking patterns within all strips of pavement.

Conclusions:
Cores should be pulled from the pavement when evaluating whether Ultra-Thin Whitetopping (UTW) is a viable rehabilitation alternative to determine if the asphalt is stripping and if the asphalt layer has adequate thickness. UTW can be successfully placed on as little as 76 mm (3 in) of asphalt, if the quality of the asphalt is good. The cores should also reveal the asphalt layer is of uniform thickness and stripping/raveling has not occurred. If these conditions exist, UTW is a good option for rehabilitating asphalt pavements.

Implementation:
The 2003-2004 RIC Program funded a project titled "Best Practices Guidelines for Thin and Ultra-Thin Whitetopping" Task 4, Report #2005-27.

Two LRRB projects studied the uses of thin and ultra thin whitetopping. They are "INV 729: Ultra-Thin and Conventional White Topping at MnROAD" and "INV 748: Cost and Performance Evaluation of Ultrathin Pavements on High Volume Intersections." In addition to the reports for these projects, several papers were written during the investigations of thin whitetopping. Although the ultimate development of procedures is some time away, this task will develop design and construction guidelines based on current knowledge including when to use thin and ultra-thin whitetopping. The guidelines will address things like optimization of pavement life.

Implementation Outcome:
A close-out memo his being written.

Report Located At:
http://www.lrrb.org/pdf200419.pdf

Related Project:
"Ultra-Thin and Conventional White Topping at MnROAD" INV 729

Report #2004-20

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Linda Zemotel, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 12

Contract Period:
September 24, 2001 to March 31, 2004

Funding:
$50,000 COPTRS

Program:
FY2002 Research Transportation Program

IMP 2005
Proposal No. 39

Increasing the Value of Public Involvement in Transportation Project Planning

Description:
Detailed case studies of successful and unsuccessful transportation public involvement efforts are discussed. A model is proposed with five independent dimensions. Researchers conclude that situations with serious conflict require different tactics built around the specific nature of conflict, and that a general theory of conflict management is a reasonable long-term goal.

Conclusions:
There are also implications that fall outside of the scope of the public involvement process for a project. In the five dimensions of conflict, the first two (size and distribution of benefits and costs, and disputes about the size or importance of impacts) are essentially local in nature, the main exception being cases where the assessment of the importance of an impact is driven by ideology. Because they are local in nature, they can reasonably be discussed and resolved at local meetings. Indeed, a large part of the point of public involvement is to tap into the more detailed understanding of impacts that can come from local residents. Identification of stakeholders can also be a local issue when the project is small in scope.

Implementation:
An Implementation Project was funded in 2005 titled "Conflict Management in Transportation Project Public Involvement" Contract 81655 WO 147

Implementation Outcome:
Close-out memo will be completed.

Report Located At:
http://www.lrrb.org/pdf200420.pdf

Report #2004-21

Principal Investigator:
Miki Hondzo, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
81655 WO 17

Contract Period:
September 1, 2001 to March 31, 2004

Funding:
$119,970 COPTRS

Program:
FY2002 Mn/DOT Transportation Research Program

Laboratory Measurements of Stormwater Quality Improvement in Detention Ponds

Description:
Pollution in detention ponds and constructed wetlands is a growing problem and this report takes a look at removal processes that are effective.

Conclusions:
Mn/DOT selected three species (*G. grandis*, *S. validus*, and *S. pectinata*) to be studies for their phytoremediation capabilities. In flow and nonflow reactor experiments, uptake rate constants were found for each species for each of the target
contaminants. The depletion rates of the target contaminants from the nutrient solution depended on the contaminant in question and the species accumulating the contaminant. None of the three species was a clear-cut best at removing the target contaminants from the nutrient solution. In the non-flow reactor experiments, *G. grandis* appeared to be the best overall for removing the target contaminants. In the flow reactor experiments, *S. validus* was the best at removing target 70 contaminants. These experiments also showed that, as is consistent with other researchers (Qian et al., 1999; Zhu et al., 1999), all three species accumulate a higher concentration of the target contaminants in their roots than they do in their stems. Chloride and phosphorus were
exceptions as they were found in higher concentrations in the stems than in the roots. It was also found that plants grown hydroponically had a higher concentration than those grown in sand, and plants grown in flow reactors removed a greater mass of contaminants than those grown in nonflow reactors.

Implementation:
There are no specific tasks from the research project that need to be implemented. Rather, we will implement the overall concept through the design of sedimentation ponds. Older sedimentation pond designs did not incorporate the use of certain emergent aquatic wetland species to remove various pollutants contained in run-off. New designs will include the 3 species examined in the research project and others to perform this function. Ponds should be designed to maximize the area where emergent aquatic species grow. This is best accomplished by mimicking natural wetlands whenever possible and providing a large bench or shelf area in the pond that is 0-6 inches deep.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200421.pdf

Report #2004-22

Principal Investigator:
Michael Wade, University of Minnesota

Technical Liaison:
Kevin Peyman, Martin County

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 15

Contract Period:
September 1, 2001 to March 30, 2004

Funding:
$46,409 LRRB

Contract Number:
81655 WO 15

Program:
CY2001 LRRB INV 775

Accident Analysis of Significant Crash Rates for Low to Very Low Volume Roadways in 10 Minnesota Counties

Description:
Traffic data from 1996 and continuing through the first half of 2001 were analyzed for roadways with low to very low traffic volumes in ten southwestern Minnesota counties resulting in information about the causes of crashes.

Conclusions:
Using the database of the 5 ½ years of accident reports provided by the Mn/DOT Office of Research, our analysis identified 15 accidents from the selected counties in Minnesota, which met the criteria for further analysis. It is clear that there are many factors other than improper driving that are related to accidents, and the general conclusion is that other than driver error, the most likely factor for accidents on highways with an ADT of less than 400 is a collision involving an animal.
Five direct comparisons using chi-square analysis compared driver error with the severity of the accident, daylight condition, and location of the first harmful event. The data (accident reports) on the 15 accident sites from the 11 counties identified were sent to county traffic engineers requesting their comments relative to such things as the nature of the highway, whether it was county assisted, county, or township, and other factors relative to the accident locations (e.g. historic lane and shoulder width changes, changing of signage or sign materials, seasonal issues, and time of day). The comments received were spasmodic and at best mixed, and we were unable to produce any conclusive information from them. It would appear overall that the analysis of the 5 ½ years of data suggests that where driver error is not a persuasive factor in the accident, the physical and structural properties of the highways in the categories included in this analysis do not play a significant role in the accidents. The largest factor relative to accidents that do not involve driver error appears to be an animal being involved in the accident.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
Knowledge Gained

Report Located At:
http://www.lrrb.org/pdf/200422.pdf

Report #2004-23

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Co-Principal Investigator:
Vaughan Voller, University of Minnesota

Technical Liaison:
Roger Olson & Shongtao Dai, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 112

Contract Period:
5/1/1999 to April 30, 2004

Funding:
$290,000 LRRB

Program:
CY1998 LRRB INV 739

Low Temperature Cracking of Asphalt Concrete Pavements

Description:
A new test method was developed to determine the low temperature fracture properties of asphalt mixtures based on experimental results and field information from MnROAD. This method can be used to select materials with better fracture resistance and better performance. Two models were developed to predict the low temperature cracking performance of asphalt pavements.

Conclusions:
The analyses performed in this research showed that the TC model included in the recently released Design Guide does is of limited value and does not correctly predict performance in climates dominated by severe temperature regimes in which single event cracking are the predominant failure mechanism at low temperatures. Based on the results obtained in the previous three parts the following recommendations are made for the development of future low temperature performance criteria:
1. First, the material parameters used in the model need to be determined at temperatures similar to the observed cracking temperatures in the field. Second, the model needs to incorporate the viscoelastic behavior of the asphalt mixtures and to be expanded to 2-D and 3-D conditions.
2. In order to improve the selection process of asphalt mixture with increased fracture resistance at low temperatures it is recommended that SCB tests should be performed according to the procedure developed in Part 2.
3. The analysis performed in Part 3 has demonstrated the potential of using the cohesive zone model approach to effectively simulate the fracture mechanism in asphalt pavements at low temperatures.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.org/prf/200423.pdf

Report #2004-24

Principal Investigator:
Tom Schnell,
University of Iowa

Co-Principal Investigator:
Carl Richey,
University of Iowa

Technical Liaison:
Michael Sheenhan,
Olmsted County

Administrative Liaison:
Jim Aamot,
Mn/DOT

Contract Number:
82646

Contract Period:
12/17/2001
to August 30, 2004

Funding:
$71,357 LRRB

Program:
CY2001 LRRB
INV 778

How To More Safely Accommodate Pedestrians Through An Intersection With Free Flow Legs

Description:
Six intersections were selected to monitor and record pedestrian and vehicle behaviors in slip lanes in Rochester, Minnesota, and potential countermeasures were evaluated for their effectiveness to convey the pedestrian presence information to the drivers, yet not interfering with the vehicle free-flow at other times.

Conclusions:
Pedestrian injuries and fatalities in free-flow legs seem to originate from an ambiguity of the priorities, and a misinterpretation of the intended system principles. Drivers do not expect to see pedestrians on free flow legs, and pedestrians exercise their right-of-way while assuming that drivers are aware of them and their expected behavior. Thus, the solution should incorporate educating the drivers by simply warning them about the existence of pedestrians in free-flow legs, while maintaining the free-flow functionality for vehicle traffic.

Our research team suggests the implementation of a sensor activated in-ground and in-sign LEDs crosswalk system on the selected free- flow leg (Intersection 3: 14th Street NE and Broadway (TH 63) in Rochester, MN). Further monitoring of the intersection *before* and *after* the implementation of the selected countermeasure will provide the grounds for assessing the effectiveness of the selected countermeasure.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200424.pdf

Report #2004-25

Principal Investigator:
Rebecca Embacher, Mn/DOT, Office of Materials

Technical Liaison:
None

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
N/A

Contract Period:
N/A

Funding:
$85,000 LRRB

Program:
CY1988 LRRB INV 738

Investigation of the Impact of Increased Winter Load Limits

Description:
This report documents the effects of increasing the winter load limits for a pilot study in Minnesota and suggests a possible method for placing and removing increased winter load limits.

Conclusions:
The conclusions from this study are limited in that the transporter was only able to cooperate with the study for 18 days on one test site and 5 days on the other two sites with a total number of trips of 1350. If the transporter had been able to begin December 21, 1998 rather than January 20, 1999, the duration of the study could have been 67 days. The following conclusions were made from the available data:

- The condition surveys conducted showed no visible signs of increased surface distress due to the increase in GVW of 6-axle tractor-trailer combinations from 391 kN (88,000 lbs.) to 416 kN (93,500 lbs.) over the 18 day period.
- There was a significant increase in the structural carrying capacity of the sites as indicated by the decrease in deflections during FWD testing and the reduced strains at MnROAD.
- Tridem axles are expected to cause less damage than tandem axles.
- The frost depth was determined with a reasonable degree of accuracy using thermocouples and Watermark sensors.
- The ability to retrieve data using a modem proved valuable to ensure data was collected remotely and reliably.
- Viable relationships were shown between FI and frost depth and between TI and thaw depth, however specific criteria that would be used for the placement and removal of winter load limits were not determined.
- The costs associated with upgrading the bridges in Minnesota will have a significant influence on how widespread higher winter load limits could be implemented and on the overall cost to change current policy.

Implementation:
Viable relationships were shown between the cumulative freezing index and frost depth and between the cumulative thawing index and thaw depth; however specific criteria that would be used for the placement and removal of winter load limits were not determined. Therefore, it was recommended to develop specific methods that utilize these indices for the placement and removal of winter load limits. Additionally, the author's recommended the installation of additional frost and temperature sensors throughout Minnesota to allow more efficient implementation of seasonal load limit policies that would maximize economic benefit and manage risk.

Implementation Outcome:
No Close-out memo was written.

Report Located At: http://www.lrrb.gen.mn.us/pdf/200425.pdf

Report #2004-26

Principal Investigator:
Reginald Souleyrette, Center for Transportation Research and Education, Iowa State University

Technical Liaison:
John Hotvet, City of Minneapolis

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
82617 WO 3

Contract Period:
May 1, 2003 to May 31, 2004

Funding:
$49,978 LRRB

Program:
CY2003 LRRB INV 796

Effectiveness of All-Red Clearance Interval on Intersection Crashes

Description:
In 2001, more than twelve per cent of all intersection crashes in the US resulted from signal violations. In an attempt to mitigate this common occurrence, most states now incorporate an "all-red" interval into the green-amber-red light sequence used to control intersection traffic.

Conclusions:
The results of this study do not support the commonly held hypothesis that an all-red clearance interval inherently improves traffic safety at signalized intersections. Tables 6- 1 and 6-2 present summary findings for the cross section study and statistical models. In all cases, signals without all-red, even when accounting for volume, lighting and signal visibility, had lower expected crashes and crash rates than intersections with the all-red clearance interval. However, a direct comparison of crashes and crash rates at intersections with and without all-red clearance intervals might be misleading since high crash locations are more likely to be considered for clearance interval modification and an all-red period is most likely to be implemented where safety is a perceived concern. Conversely, intersections with high crash histories tend to feature higher traffic volumes, and increasing clearance intervals will adversely impact delay and congestion, especially during peak periods.

This study found agreement with other research, in that short-term (one year) safety improvements do result from implementation of a red clearance interval, but these benefits are not sustainable and may in fact be mitigated by reduced capacity (Tables 6-3 and 6-4). Familiarity with an established clearance interval after a period of use may contribute to increasing crash rates as some drivers continue to enter the intersection after onset of a yellow signal.

Implementation:
In general, implementation will include advising local engineers to not implement all-red phases at low-speed urban signalized intersections, and to consider removing all-red phasing from low speed urban intersections where traffic volumes are high and speeds are low at selected intersections (those with low incidence of red light violation type crashes and high traffic volumes).

Implementation Outcome:
Change with no measures.

Report Located At: http://www.lrrb.gen.mn.us/pdf/200426.pdf

Report #2004-27

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Nick Thompson, Mn/DOT, Metropolitan District

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 66

Contract Period:
March 17, 2003 to June 30, 2003

Funding:
$91,375 Engineering Services Support (Office of Traffic)

Program:
FY2004 Research Transportation Program

The Effectiveness and Safety of Traffic and Non-Traffic Related Messages Presented on Changeable Message Signs (CMS)

Description:
This report takes a look at Changeable Message Signs used on freeways to determine if they really work and what is the reaction time for driver response.

Conclusions:
The researches recommend that the Minnesota Department of Public Safety increase its efforts to make the public more aware of the AMBER Alert system. We also recommend that the message be changed. It is particularly difficult to remember the license plate number. Instead, the AMBER Alert CMS Message should tell drivers to tune into an appropriate radio station, whose call sign will be easier to remember. When they tune into that station, the full AMBER Alert message,
including the license plate number should be repeated frequently. This repetition will greatly aid drivers, making it more likely that the license plate number information will be moved from working (or short-term) memory to long-term memory, where it can be retained for a longer period of time. This will greatly increase the likelihood that if a driver encounters the vehicle mentioned on the AMBER Alert he or she will be able to recognize it. It is also likely that there will be fewer slow-downs than were found in this experiment. We also recommend changing the message in Crash CMS Messages so that they say “ROAD CLOSED”—this should greatly increase the number of drivers who take the exit—or “LANE CLOSED”—so that the information would be conveyed more clearly to drivers allowing them to make an informed choice about whether or not to stay on the freeway. The effect of previous exposure to Category III CMS messages was complex and remains a question for further research following an improvement in how easily the message content is understood.

Implementation:
Mn/DOT has made minor changes to its message signs. "Amber Alert" is now "Abducted Child". They have also simplified some of their traffic messages based on recommendations by the researchers. Mn/DOT is also in negotiations with radio stations to follow some of the recommendations of the report.

Implementation Outcome:
Change without measures.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200427.pdf

Report #2004-28

Principal Investigator:
Jerry Fruin, University of Minnesota

Technical Liaison:
Richard Lambert, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 52

Contract Period:
October 7, 2002 to June 30, 2004

Funding:
$40,000 STIP

Program:
FY2002 Mn/DOT Transportation Research

Modal Shifts from the Mississippi River and Duluth/Superior to Land Transportation

Description:
This study estimates the monetary and public externality costs imposed by this 'modal shift' from barge to truck, including haulage costs, differences in fuel consumption, changes in air emissions, highway congestion impacts, highway accident impacts, and changes in highway maintenance requirements.

Conclusions:
The researchers interpret the primary purpose of this study as follows: If the Minneapolis Upper Harbor loses access to barge transport, what changes in truck traffic are expected to result; what are the expected routes of this traffic; and what are the expected private and public costs. The public costs to be considered include highway maintenance costs and public externalities such as emissions, congestion, and accidents.

This study finds that the Upper Harbor Terminal would disappear if freight could no longer move by water to/from the Minneapolis Upper Harbor. However, the freight traffic currently using the UHT would not disappear; it would be replaced by truck trips through the Metro area on I694 and I35E to St. Paul. The other Upper Harbor facilities would stay or, with significant private and public expenditure on new infrastructure (and possible public expenditure on financial compensation), move towards the northwest. With or without relocation, there would be substantial additional truck traffic through and between St. Paul and Minneapolis on I94.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200428.pdf

Report #2004-29

Principal Investigator:
Taek Kwon, University of Minnesota—Duluth

Technical Liaison:
Mark Flinner, Mn/DOT, Office of Transportation Data and Analysis

Administrative Liaison:
N/A

Contract Number:
81655 WO 4

Contract Period:
February 4, 2002 to July 31, 2003

Funding:
$40,715 Center for Transportation Studies

Program:
Traffic/ITS

TMC Traffic Data Automation For Mn/DOT's Traffic Monitoring Program

Description:
This study found that data imputation techniques based on spatial and temporal inferences of traffic flow can overcome the difficulties and produce accurate statistical data, and describes the details on actual implementation of the algorithms developed, analysis utilities and practical system integration examples.

Conclusions:
This project was started with a goal of automating the continuous and short duration count data for the portion of TMC traffic data. In the process, one important issue which the research team spent the most amount of time on was how to deal with the missing and incorrect data that exist in the TMC traffic data. First, all identifiable incorrect data points were simply treated as missing data since we do not know the amount of incorrectness. Thus the problem was simplified to dealing with only missing data. The finding is that missing data can be effectively imputed with the values that are very close to the real values if we utilize observable spatial and temporal relations of traffic flow. For utilization of spatial relation, this project introduced multiple redundant sets of detectors that are defined (or allocated) for each station by locating the detector sets that have an equivalency relation in terms of traffic flow. Since this approach is essentially equivalent to creating redundancy in data through availability of additional data from the vicinity of the primary detectors, it enabled replacement of missing data from the equivalent set of data. It should be noted that the use of spatial redundancy was possible because the TMC traffic sensor network was densely implemented (loops were installed at every 0.5 miles), which is one of the advantages of using ITS generated traffic data for traffic counting program. This strategy significantly improved the data quality by reducing the number of missing data when three sets of detectors (primary, secondary and tertiary) were assigned.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf200429.pdf

Report #2004-30

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Technical Liaison:
John Garrity, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 56

Contract Period:
January 13, 2003 to September 30, 2004

Funding:
$52,805
STIP

Program:
FY2003 Mn/DOT Transportation Research

Validation of Superpave Fine Aggregate Angularity Values

Description:
Testing was performed on four asphalt mixtures representing a range of Minnesota FAA values. Dynamic modulus testing was performed at three temperatures and five frequencies.

Conclusions:
A correlation matrix for all the material parameters measured or calculated in this study was developed using statistical software. The results shown in chapter 8 indicate that the APA rut measurements have the highest correlation with FAA(R^2 = 91.6%). Correlation results show strong relationships between rut resistance and several other characteristics, including digital imaging characterization measurements of Gradient Angularity, Radian Angularity, and Form Index.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200430.pdf

Report #2004-31

Principal Investigator:
Max Donath, University of Minnesota

Co-Principal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
Ray Starr, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
81655 WO 33

Contract Period:
September 3, 2002 to June 30, 2006

Funding:
$2,075,436
(this amount is for 5 reports)

Program:
ITS

Review of Minnesota's Rural Intersection Crashes: Methodology for Identifying Intersections for Intersection Decision Support (IDS)

Description:
The objective in studying the causes of crashes at rural intersections is to support development of technology based strategies to mitigate high crash rates.

Conclusions:
Minnesota's rural crash records were analyzed in order to develop a better understanding of crashes at rural intersections and their cause. The objective in studying the causes of crashes at rural intersections is to support development of technology based strategies to mitigate high crash rates. Since previous research found that 80 percent of intersection crashes at thru-STOP intersections may be related to selection of insufficient gaps, the development and validation of Intersection Decision Support (IDS) technology that assists in proper gap selection was identified as a primary goal. A database of over 3,700 intersections was examined. Using the critical crash rate as an indicator, 23 rural expressway intersections and 104 rural two-lane intersections were identified as unusually "dangerous" locations. Right angle crashes (which are most often related to gap selection) were observed to account for approximately 50 percent of all crashes at the "dangerous" intersections, up from 28 percent for all rural thru-STOP intersections. A specific intersection identified, evaluated and then was selected for testing IDS technologies that can track vehicles approaching on the major roadway, compute the gap and communicate the information to drivers stopped on the minor street waiting to enter the intersection. The data acquisition system to be installed will allow analysis of driver decision making behavior and study the effects of introducing an IDS under development at the University of Minnesota.

Implementation:
No Implementation Plan was written.

Featured in the FHWA's Research and Technology Transporter October 2004 edition

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.org/pdf/200431.pdf

Report #2004-32

Principal Investigator:
Peter Graham, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
74708 WO 178

Contract Period:
August 17, 2000 to September 30, 2004

Funding:
$80,846
COPTRS

Program:
Mn/DOT Transportation Research Program

Inoculated Legumes and Revegetation/Roadside Plantings

Description:
The predominate goal of this study was the establishment, inoculation and continuing observation for traits associated with nodulation and nitrogen fixation of prairie lands of different ages at the University of Minnesota Sandplain Experiment Station in Becker, Minnesota.

Conclusions:
In response to the vast loss of prairie area in western and southern Minnesota and the concern over plant genetic loss and soil erosion that resulted, this study set to determine the success of prairie reconstruction along Minnesota roadways. Areas around rest stops on major highways were seeded with prairie plants. As nitrogen is commonly limited in natural environments, legumes- known for their ability to fix nitrogen in symbiosis were included in the prairie reconstruction plant mixes. However, not all of the land area contains sufficient rhizobia to maintain the legumes. Therefore, inoculation with rhizobia was necessary. The predominate goal of this study was the establishment, inoculation and continuing observation for traits associated with nodulation and nitrogen fixation of prairie lands of different ages at the University of Minnesota Sandplain Experiment Station in Becker, Minnesota. The area was then monitored for plant development and survival.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
http://www.lrrb.org/pdf/200432.pdf

Related Research Projects:
"Improving the Nodulation and Nitrogen (N2) Fixation of Prairie Legumes Used in Roadside Revegetation in Minnesota" 74708 WO 52

"Improved methodologies for the inoculation of prairie legumes in roadside/revegetation settings" 81655 WO 127

Report #2004-33

Principal Investigator:
Thomas Smith, University of Minnesota

Technical Liaison:
Brad Estochen, Mn/DOT, Metro—Engineering Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 163

Contract Period:
July 14, 2000 to June 3, 2004

Funding:
$19,866 CTS
$17,500 Guidestar
$17,500 STIP

Program:
FY1999 Guidestar and Mn/DOT Research Transportation Program

Reducing Risk Taking at Passive Railroad Crossings With Active Warnings

Description:
This report evaluates driver interaction in regards to low cost active warning systems located at passive-rail intersections.

Conclusions:
Major results are: (1) statistically significant main effects of train (present/absent), visibility (clear/foggy), and Xing WS conditions; (2) incidents of vehicle beating train or hitting train are higher for trials with a passive advance WS, relative to those with an active advance WS; (3) with a train present and clear visibility, for all measurement intervals, active advance WS are associated with lower mean vehicle speeds, compared to mean speeds observed with passive advance WS; (4) active advance and Xing WS are perceived by PTQ respondents to be more usable and more conspicuous than passive advance and Xing WS ; and (5) flashing words (e.g., a VMS) are perceived by PTQ respondents to be more conspicuous than flashing lights on an active advance HRI WS.

Implementation:
The summary conclusions of the study, based on observations from train-present trials are that: relative to HRIs with passive crossing crossbuck signs and passive advance warning signs, HRIs with active crossing crossbuck signs and advance warnings are associated with:
1) Fewer incidents of unsafe vehicle-train interactions
2) More cautious simulated driving performance as the vehicle approaches the HRI
3) More favorable subject perceptions regarding warning sign usability and meaning.
These conclusions suggest that field deployment of both active advance warning signs and active crossing crossbuck signs at HRIs will benefit driving safety during vehicle-train interactions. The findings therefore tend to validate the decision by Mn/DOT to support development of a low-cost active warning system, targeted for installation at currently passive HRIs.

The Minnesota Guidestar operational test, Low-Cost Active Warning for Low-volume Highway/Rail Intersections will be completed by December, 2004. The final evaluation report will include an assessment of system performance, an assessment of system impacts (safety/crashes), a documentation of system costs and identify deployment issues. The evaluation will document the characteristics of the system, including its impact on drivers, implementation, operations and maintenance costs, and adaptability, and compare those characteristics to those of traditional active warning system.

The purpose of the Low-Cost HRI Warning Project, and therefore the evaluation effort as well, is to determine whether the system can perform as well, or better, at low-volume crossings than the more costly traditional active warning systems. To the extent that the low-cost system is found lacking, the evaluation must provide information that will support future refinement of the system.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200433.pdf

Report #2004-34

Principal Investigator:
Vladimir Cherkassky, University of Minnesota

Technical Liaison:
Ray Starr, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 38

Contract Period:
January 1, 2003 to July 30, 2004

Funding:
$44,000 Guidestar
$11,000 STIP

Program:
FY2002 Guidestar
FY2003 Mn/DOT Transportation Research

Implementation of Quality of Service (QoS) with Dynamic Resource Allocation

Description:
This project uses freely available software and low cost hardware to provide a system that monitors traffic conditions on highway systems.

Conclusions:
As more and more networks are starting to use time dependent network services such as voice over IP or streaming video, network performance is becoming critical in providing the required quality of service required for such applications. Upgrading bandwidth is not a cheap solution nor is it a long lasting one. Traffic prioritization and bandwidth allocation offers a less expensive and a more permanent solution to these problems. The goal of this project was the implementation of the traffic prioritization and bandwidth allocation and that is exactly what was done. The network is able to support several streams of data, a camera control channel, and low priority traffic. Users can assign priorities to different types of network data streams quickly without any packet loss. The quality of streaming video is greatly improved and the delay of packets over camera control channels is reduced. No more slow camera response or video streams of accidents at 5 frames per second. A comparison between networks with QoS vs. networks without QoS showed that in the worst case scenario, streaming video frame rate was improved by over 450% and packet delay was reduced by 600% when using QoS. Mn/DOT would greatly benefit from the use of ALTQ QoS in its network, especially at bottlenecked remote sites. The price for implementing QoS is lower than upgrading the bandwidth of a network link that spans several miles. While upgrading may solve short term problems, the addition of more network traffic will bring the network to a crawl once again. QoS is scalable and can grow with the network to accommodate more network load and addition of more sources of network traffic.

Implementation:
Mn/DOT did not implement the results of the study. The networks used for the systems have been adequate for their intended purpose. To implement the results, additional hardware is required, and the software must be configured.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200434.pdf

Report #2004-35

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Co-Principal Investigator:
Gene Skok, University of Minnesota

Technical Liaison:
Jim McGraw, Mn/DOT, Office of Materials

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
81655 WO 64

Contract Period:
December 1, 2002 to July 30, 2004

Funding:
$44,389
STIP

Program:
FY2003 Mn/DOT Transportation Research

Inventory of Properties of Minnesota Certified Asphalt Binders

Description:
A literature search was performed to identify existing databases as well as more complex test methods for asphalt binder characterization that have been proposed recently.

Conclusions:
The goal of this project was not so much to exhaustively analyze the binders in terms of their relative performance to one another, but to simply understand how to perform the tests and then catalogue the data in a database for future reference. This was accomplished successfully.

The Bending Beam Rheometer (BBR) and Direct Tension Tester (DTT) were used together to determine the critical cracking temperature of the binders at low temperatures. A majority of the laboratory work in this project involved testing with the Dynamic Shear Rheometer (DSR). Frequency sweeps were performed over a range of temperatures. This data was used to generate master curves and to calculate zero shear viscosity, the latter of which is being proposed as a new high temperature performance specification. Strain sweeps verified that frequency sweep testing was performed in the linear viscoelastic range. Repeated creep tests measured the permanent strain accumulated after 100 cycles, which is also being proposed as a specification test indicative of rut resistance in asphalt pavements. Fatigue tests were performed at intermediate temperatures. The data from this test gave an indication of the fatigue cracking performance of asphalt pavements in the field. A database was created in Microsoft Access, which is easy to use and readily available to most users. Test results, along with some model parameters, were stored in tables inside the database. As more test results become available, the can easily be imported to the database.

Implementation:
The database will be used by Mn/DOT engineers, and Minnesota city and county engineers and specifiers for the selection of binders for specific applications. It compares how polymer-modified binders will perform compared to straight-run asphalts. It also compares different modifiers of like binders, such as 58-34. There has been no decision on how this information will be presented. The database can be used to evaluate binders for rutting, fatigue cracking and thermal cracking. Mn/DOT will also evaluate the differences between suppliers.

Implementation Outcome:
Change with no measures.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200435.pdf

Report #2004-36

Principal Investigator:
Susan Galatowitsch, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
74708 WO 173

Contract Period:
July 1, 2000 to August 3, 2004

Funding:
$68,892 STIP

Program:
Mn/DOT Transportation Research Program

Best Management Practices for the Invasive Phalaris arundinacea L. (Reed canary grass) in Wetland Restorations

Description:
This research developed a predictive understanding of P. arundinacea (a perennial grass) dominance in prairie pothole wetland restorations and investigated potential control techniques.

Conclusions:
Results from this research determined the most effective use of burning and glyphosate herbicide to control existing stands of *P. arundinacea* (burning to reduce the seed bank, and later season herbicide applications to maximize rhizome mortality). However, even 2 years of the most effective use of herbicide and burning are not sufficient to reduce *P. arundinacea* dominance to the point where native species can establish. Recolonization from seed (either onsite in the seed bank or off-site from dispersal) will complicate control techniques. *P. arundinacea* can establish from very low propagule densities (even when native species propagule densities are high), and once established, grows rapidly and in a way that facilitates preemption over other simultaneously establishing species. Long-term management of reinvading *P. arundinacea*, and limiting availability of *P. arundinacea* propagules in the landscape, will therefore be key to successful *P. arundinacea* control.

In summary, the research has demonstrated that the most effective way to control *P. arundinacea* is a combination of later season herbicide applications to maximize rhizome mortality, and burning to reduce the *P. arundinacea* seed bank density. Controlling *P. arundinacea* in the most efficient way is crucial to the establishment of native vegetation in wetland restorations. Reduction of *P. arundinacea* is a long-term process and one that is complicated by potential reinvasion of cleared sites, so control efforts must be as effective as possible. Moreover, *P. arundinacea* is still widely cultivated as a forage crop and planted as a conservation species (15, 16), and these populations may serve as sources of continuing propagule pressure, further complicating localized eradication efforts. The contribution of planted populations to the spread of *P. arundinacea* into natural areas is not well understood, however efforts to restore biodiversity may benefit from practices that reduce *P. arundinacea* propagule pressure from planted sources (e.g. restricting use of *P. arundinacea* where nonaggressive species could be substituted, and preventing seed set from cultivated populations of *P. arundinacea*).

Implementation:
Several implementation activities have been accomplished, most of which were accomplished by Robert Jacobson, MnDOT Office of Environmental Services (OES). Robert developed a Wetland Restoration & Management Manual for the Board of Soil & Water Resources (BWSR) last year, which includes information outlining several results from this project. The manual is accessible from Mn/DOT OES's website. He will be working at BWSR under an Interagency Personnel Agreement (IPA) for a year and after that will be working 50% time with BWSR on wetland restoration as part of the "Cooperative" for an additional 4 years. Results have also been incorporated into the BWSR:Mn/DOT Wetland Cooperative & Streamlining project. Beginning July 2005, Mn/DOT transferred most of its wetland restoration activities to BWSR, and they are using the information. Mn/DOT already had been implementing the results of this research on its wetland projects since 2003, which will now continue after BWSR assumes these activities for Mn/DOT. Minnesota Water Conservation Districts (SWCD's) are implementing results at the local level on wetland projects. The Army Corps of Engineers (COE) is also implementing the results of the research through the Federal 404 permitting process, and BWSR is implementing through the Wetland Conservation Act (WCA) process.

Implementation Outcome:
Change with no measures.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/.200436pdf

Report #2004-37

Principal Investigator:
David Levinson, University of Minnesota

Technical Liaison:
Linda Taylor, Mn/DOT, Currently Office of Maintenance

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
74708 WO 162

Contract Period:
7/14/2000 to October 31, 2002

Funding:
$161,082 STIP

Program:
Mn/DOT Transportation Research Program

Measuring the Equity and Efficiency of Ramp Meters

Description:
This study aims to develop both efficient and equitable freeway ramp control strategies

Conclusions:
This study developed a new theory of efficient and equitable ramp metering control. The study has developed measures of efficiency and equity of ramp meters, formulated the optimal ramp control problem without requiring origin-destination (OD) information estimation, provided a heuristic solution to it, created an analytical framework under which future ramp metering research can be conducted, developed and coded a new family of ramp metering algorithms with different equity consideration, and introduced a new ramp metering objective and shown how it can be used to balance efficiency and equity of ramp control strategies.

Implementation:
Since the time the project was started Mn/DOT has fundamentally changed their metering goals, operations and algorithms. Much of this study was based on showing improvement over part of their previous metering control strategy, no longer in use. Therefore, Mn/DOT doesn't see a use for the findings in their operations, nor see a need to expand the project for additional study. Mn/DOT's new strategy specifically takes ramp delay into consideration as this study suggests. However, the proposed algorithm cannot work within the new framework of capping ramp delays at 4 minutes local and 2 minutes freeway to freeway and also prevent queues from backing up onto local streets.

No implementation of the results will occur.

Implementation Outcome:
Results not useable

Report Located At:
http://www.lrrb.org/pdf/200437.pdf

Report #2004-38

Principal Investigator:
Karl Smith, University of Minnesota

Technical Liaison:
Jim Weingartz, Mn/DOT, Office of Technical Support

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 34

Contract Period:
May 20, 2002 to November 30, 2003

Funding:
$79,081 COPTRS

Program:
FY2003 Mn/DOT Transportation Research

Developing Project Management Expertise

Description:
This research provides insight into the effectiveness of the Project Management Academy (PMA), instituted by Mn/DOT in 1993 to improve skills of project managers throughout the organization. In order to evaluate the Mn/DOT PMA, these researchers employed extensive literature search; interviewed PMA participants; and conducted in-depth interviews with a sub-set of the focus group. The primary intent was to determine what-if any--influence this training has on the overall ability of managers to do their jobs and make recommendations for improvement.

Conclusions:
In conclusion, the three gaps found in the academy,
1. the academy's central message;
2. instructional focus and format; and
3. and the diverse participant profile

each reveal four main categories of recommendations that can help enhance the effectiveness of
the academy:
1. Aligning the PMA with the goals and mission of the organization;
2. Making connections;
3. Incorporating ways knowledge is managed; and
4. Clarifying the audience.

Each of the gaps is analyzed from literature in best practices in project management, training, PMA material, and focus group and participant evaluations. The recommendations are intended to serve as a foundation for enhancing the Mn/DOT Project Management Academy.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.org/pdf/200438.pdf

Report #2004-39

Principal Investigator:
Joseph Labuz, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
81655 WO 32

Contract Period:
April 15, 2003 to September 30, 2004

Funding:
$25,000 STIP

Program:
FY2002 Implementation Funding Program

Small Strain and Resilient Modulus Testing of Granular Soils

Description:
Thirty-six resilient modulus tests were performed on samples of six soils that are commonly used within pavement structures in Minnesota, in order to calculate levels of moisture in construction areas.

Conclusions:
This study involved a comparative resilient modulus and bender element testing of 36 triaxial specimens. Six granular soils representative of base and subgrade materials found in Minnesota were used. These specimens were prepared at three different moisture contents per soil and compacted to their standard Proctor optimum dry density. Each specimen was subjected to resilient modulus testing as specified by Mn/DOT modified LTPP P46. The loading sequences of this test were halted periodically to perform small strain bender element testing, which can establish relative maximum modulus values by measuring wave speeds. Following the test protocol, the specimens were loaded until failure to determine their shear strength. The objective of this testing was to measure the resilient modulus values of reference soil samples while establishing a relationship between the resilient modulus and the maximum modulus of these soils. A number of conclusions were reached during this investigation.

1) The hyperbolic model is able to accurately model the strain-dependent modulus reduction of a soil using only the small-strain modulus, friction angle, and cohesion as input parameters.

2) The modulus and strength of soils tested increased as their moisture contents decreased. This trend was visible in the results from the resilient modulus, bender element, and triaxial strength testing.

3) The three LVDTs used as a part of the triaxial testing setup often measured displacement values that were in poor agreement with each other.

4) The best estimate of the gravimetric moisture content from the dielectric permittivity values in this study is $\omega = 1.18k-3.47$

However, this relation often produces moisture content differences of 0.03 to 4.63 percent from the oven dried values, and is unproven for soils other than the six used in this study.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.org/pdf/200439.pdf

Related Projects:
"Enhanced Portable Device for Subgrade and Granular Base Characterization" 74708 WO 185
"Moisture Effects on DCP and PFWD Measurements - Phase I (CTS FUNDED)"
"Moisture Effects on DCP and Portable Vibratory Deflectometer (PVD) Measurements - Phase II" 81655 WO 57

Report #2004-41

Principal Investigator:
David Biesboer, University of Minnesota

Technical Liaison:
Dwayne Stenlund, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 140

Contract Period:
October 8, 1999 to September 30, 2004

Funding:
$80,000
STIP

Program:
Mn/DOT Transportation Research Program

The Effect of Novel Soil Amendments on Roadside Establishment of Cover Crop and Native Prairie Plant Species

Description:
This report examined the concept that application of amendments to the soil or over the soil might have the capacity to increase fertility, increase soil moisture, or moderate the harsh microclimate of the inslope.

Conclusions:
Many states have been seeding their roadsides with a cover crop/native species mix for several decades. One common complaint when native species establishment appears to be extremely low is that roadside soil conditions may be too inhospitable for the establishment of desirable natives. It has been hypothesized that application of amendments which have the capacity to increase soil moisture and fertility may be an effective means to assure a more reliable recruitment of native species. In this study three different soil amendments were used: two types of erosion control ma ts including a MnDOT Category 00 rapid degrade, stitch- free erosion control blanket (Futerra®) and hydraulic application of a recycled paper/wood fiber/natural soil stabilizer (Soil Guard®); and the addition of natural organic matter. The two erosion control materials (ECMs) are products thought to possibly be capable of changing soil temperatures, inhibiting soil moisture loss and/or enhancing the moisture aspect of the soil surface microclimate. The addition of organic matter is known to increase both soil water-holding capacity and fertility.

Implementation:
None

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.org/pdf/200441.pdf

Report #2004-42

Principal Investigator:
Frank Douma, University of Minnesota

Technical Liaison:
Ken Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
81655 WO 45

Contract Period:
March 1, 2003 to November 30, 2004

Funding:
$360,000 Guidestar
$90,000 STIP

Program:
FY2002 Guidestar
FY2003 Mn/DOT Transportation Research

Using ITS to Better Serve Diverse Populations

Description:
Provide data and analysis to help predict future travel behavior, identify suitable ITS technologies to meet the emerging travel needs, and plan transportation systems based on emerging demographic patterns.

Conclusions:
This project begins investigation into ways Intelligent Transportation Systems (ITS) can be used to serve the transportation needs of "non-traditional" populations. The report consists of three sections: the first examines recent demographic data to assess the potential demand for new ITS applications, concluding that the "nontraditional" populations that could most benefit from these applications are senior citizens, immigrant and non-English-speaking populations, and the disabled; the second section presents findings from efforts to collect primary data from these groups in surveys and focus groups; and the third section presents an assessment of community-based transit (CBT), carsharing, telework and telemedicine, and advanced traveler information services (ATIS), which are ITS applications that could benefit these populations. The results of this research show that CBT holds the greatest potential for serving the needs of each of the identified populations, while carsharing also presents significant opportunities for the immigrant populations. In addition, the findings suggest that combining ATIS with CBT or carsharing could create even greater benefits by allowing users to customize ATIS for the modes that serve them most effectively.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.org/pdf/200442.pdf

Related Projects:
"Telecommunications and Sustainable Transportation " 81655 WO 5
"Developing ITS to Serve Diverse Populations" 81655 WO 99

Report #2004-43

Principal Investigator:
Cathy French, University of Minnesota

CoPrincipal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
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Administrative Liaison:
Barb Loida, Mn/DOT

Contract Number:
74708 WO 192

Contract Period:
February 1, 2001 to November 1, 2004

Funding:
$99,999
LRRB

Program:
CY2000 LRRB
INV 700(2)

Behavior of Concrete Integral Abutment Bridges

Description:
Integral Abutment (IA) bridges are designed and constructed with no joints in the superstructure or between the superstructure and the supporting abutments.

Conclusions:
The behavior of concrete integral abutment bridges was investigated through a field experiment and a numerical parametric study. The field investigation focused on a bridge, Bridge #55555, in Rochester, MN, which was monitored from November 1996 to February 2004. Over 150 instruments were installed during construction of the bridge to measure abutment horizontal movement, abutment rotation, abutment pile strains, earth pressure, pier pile strains, prestressed girder strains, concrete deck strains, thermal gradients, and weather. Measured data from the electrical sensors were automatically collected every six hours through four dataloggers. The collected data over the past seven years was analyzed to understand the behavior of Bridge #55555 due to the effects of temperature, creep, and shrinkage. Two live load tests were conducted in 1997 and 1999, respectively, to examine the behavior of the bridge under live load.

The overall performance of the integral abutment bridge was good. The live load test results indicated that the bridge behaved as a series of individual spans. The center span behavior was very similar to a simple span. The end span behavior fell between a simple span model and a fixed-pinned model indicating the abutment substructure provided some rotational restraint to the end-span girders.

Implementation:
Bridge engineers at Mn/DOT are considering the researcher's recommendations. Since the inception of this research project, other states have pursued their own research on this issue, and their results will complement the results of Minnesota's project. The report serves as an excellent resource and will be used in conjunction with the experiences from other states for additional discussions on specific recommendations. Minnesota is hosting a meeting of the north central states in September 2005 where integral abutment bridges will be a topic.

The results of this project helped confirm some of the guidelines Mn/DOT had recently put into use regarding the design of integral abutment bridges in recent years. For instance, Mn/DOT doubled the allowable length of IA bridges to 300 feet and removed the limitations on beam size. The research supports these changes.

One benefit of I/A bridges is that the expansion joint is located at the end of the approach panel instead of on the end of the bridge. This location allows for easier maintenance of the joint. Typically, expansion joints require regular maintenance no matter where they are located. By making the work easier, lower maintenance costs can be expected.

As additional research results became available, the bridge approach treatment standard sheets for roadway design standard plans were revised to include specific details when using integral abutment bridges. Other changes in design may occur pending the incorporation of further research from other states with Minnesota's results. This project should be reviewed in one year for any additional evaluation or implementation.

Implementation Outcome:
Change with no measures.

Report Located At:
http://www.lrrb.org/pdf/200443.pdf

Related Project:
"Field Performance of an Integral Abutment Bridge - Phase I" INV 700, 73500 WO 179

Report #2004-44

Principal Investigator:
Mihai Marasteanu, University of Minnesota

CoPrincipal Investigator:
Gene Skok, University of Minnesota

Technical Liaison:
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Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
December 1, 2002 to December 30, 2004

Contract Number:
81655 WO 63

Funding:
$54,000
LRRB

Program:
CY2002 LRRB
INV 783

Development of Simple Asphalt Test for Determination of RAP Blending Charts

Description:
The purpose of this study was to investigate the possibility of developing a simple test that could be used to obtain asphalt binder properties that are required in developing blending charts to select the appropriate percentage of RAP.

Conclusions:
The preliminary investigation performed in this study resulted in the following conclusions:
1) The BBR tests performed on thin beams of asphalt mixture show a lot of promise in measuring the creep compliance (and stiffness) of asphalt mixtures.
2) The advantages of this method over the traditional IDT method are evident:
- less expensive testing equipment,
- no need for extensometers placed on the test specimens,
- use of smaller specimens that can be used in studying aging effects across the depth of the asphalt layers,
- less destructive filed sampling.
• The Hirsch model can be used to backcalculate binder stiffness from the BBR mixture stiffness. In its present form the model under-predicts the binder stiffness compared to the stiffness measured on extracted binders but the trend in comparing different mixtures is identical to the one seen by performing tests on extracted binders.
• Additional research is needed to further investigate this model and refine it to obtain reasonable stiffness values and from these, determine binder m-values. It appears that in the 83 present form the mixture stiffness is over-sensitive to the input binder stiffness, which is not
reasonable.

Based on the work performed in this study a procedure was recommended for developing blending charts for pavements built with RAP material. This procedure follows very closely the method proposed in NCHRP 9-12 and described in the literature review chapter. However,
instead of extracting the binder from the RAP material the binder properties are obtained by back-calculation from mixture properties using the Hirsch model as previously described in this section.

Implementation:
No implementation has occurred. Based on the results of this study, no additional research has been proposed. The researchers noted that additional work must be completed before this test would be usable. Other researchers have done work on the Hirsh model. However, Mn/DOT has no plan to use the Hirsh model to create blending charts at this time.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.org/pdf/200444.pdf

Report #2004-45

Principal Investigator:
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CoPrincipal Investigator:
Nikolaos Papanikolopoulos, University of Minnesota

Technical Liaison:
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Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
81655 WO 1

Contract Period:
March 3, 2003 to December 31, 2004

Funding:
$156,000 Guidestar
$39,000 STIP

Program:
FY2001 Guidestar
FY2002 Mn/DOT Transportation Research

Real-Time Collision Warning and Avoidance at Intersections

Description:
This report studies real-time intersections in hopes of finding a method for predicting collisions in order to build an early warning system.

Conclusions:
A vision-based system for monitoring traffic intersections that issues warnings about imminent collisions was presented. The sensors used comprise of one or more fixed video cameras, calibrated in advance of the system's operation. Instabilities in the input video due to camera shaking, sudden illumination changes, and weather conditions (e.g. light rain) are handled automatically by the low-level vision components of the system. Accurate velocity, position, and size information in real-world units is obtained for each vehicle in the scene by the high-level vision components of the system. The collision prediction module makes use of this data to predict vehicle trajectories and report collisions. The data generated by the system is also suitable for vehicle classification purposes and for categorization of the severity of collisions. The system is robust to temporary static and dynamic occlusions, and is capable of handling the stop-and-go situations that occur in the setting of a traffic intersection. The proposed algorithms were implemented on general-purpose computer system without specialized vision-processing hardware. Realtime performance (greater than 30 Hz sampling rate) on videos of sufficient resolution was achieved.

Implementation:
According to the project scope, this work was to be exploratory in nature, to evaluate feasibility, and was not intended to provide generalized software that could be used by Mn/DOT at an arbitrary intersection. The project did achieve its goal. It was understood that additional work would be needed if the results of the research supported making it into a real-time production system that could be implemented in a real-world intersection. Mn/DOT determined that the terms of the contract had been substantially met.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.org/pdf/200445.pdf

Report #2004-46

Principal Investigator:
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Technical Liaison:
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Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
71079

Contract Period:
September 29, 1993 to December 31, 1995

Funding:
$179,000 Minnesota Legislative Commission for Minnesota Resources (LCMR)

Program:
Pavement

Mitigating Concrete Aggregate Problems in Minnesota

Description:
This reports looks into the causes of cracking/failure of concrete pavements in order to evaluate and develop techniques to improve freeze-thaw durability.

Conclusions:
The results of this research indicate that the poor durability performance of PCC pavement sections in southern Minnesota can, in many cases, be attributed to the susceptibility of coarse aggregates to freeze-thaw damage; however, secondary mineralization, embedded shale deposits, poor mix design and alkali-aggregate reactions were also identified as problems that can aggravate D-cracking or appear similar to it. Petrographic examination of pavement cores can help to differentiate between these different failure mechanisms.

A single quick, simple, economical and reliable method for identifying frost-susceptible aggregate particles was not identified, although there are quick tests that can be used to determine the frost resistance of one aggregate relative to others. Whether an aggregate can resist repeated cycles of freezing and thawing can sometimes be answered only by tests that simulate field exposure conditions
(such as ASTM C 666).

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.org/pdf/200446.pdf

Report #2004-47

Principal Investigator:
Omid Mohseni, University of Minnesota

CoPrincipal Investigator:
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Technical Liaison:
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Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
81655 WO 70

Contract Period:
May 1, 2003 to November 30, 2004

Funding:
$55,543
STIP

Program:
FY2003 Mn/DOT Transportation Research

Scoping Study for the Development of Design Guidelines for Bioengineering in the Upper Midwest

Description:
This report comprises (a) a summary of literature review, (b) interviews with eleven practitioners in the field, (c) an evaluation of three projects done in Minnesota, (d) current research needs, (e) and a brief evaluation of three sites in the vicinity of the Twin Cities area as potential outdoor laboratories to conduct research in the needed areas.

Conclusions:
The study, specifically the interviews, shows that despite an increasing popularity in using the soil bioengineering techniques to protect streambanks and slopes, the field is more of an art than a science. A significant number of studies have been done on different topics related to soil bioengineering techniques, however, the studies mainly address the problems at a micro scale, and hence, there is a gap between existing knowledge and practice. Therefore, there is an urgent need to not only study some of the fundamental processes and mechanisms involved in soil bioengineering techniques, but also to investigate these processes at a macro scale to evaluate their strengths and impacts when applied to streambanks and slopes.

Implementation:
Include the new guidelines for bioengineering practices into the current one-day LTAP Erosion Control course. Rename that course "Maintaining a healthy roadside environment through bioengineering and erosion control best practices". Offer it to local engineering and management staff (at the state, cities, counties and townships). Use the newly developed "Minnesota Soil Bioengineering Handbook" (developed by the MnDOT Office of Environmental Services) as a text for the course, as well as the *Erosion Control Handbook for Local Roads* and the *Best Management Practices for Roadside Vegetation* and other DNR and MPCA materials.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.org/pdf/200447.pdf

Report #2004-48

Principal Investigator:
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Administrative Liaison:
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Contract Number:
81655 WO 14

Contract Period:
September 1, 2001 to December 30, 2004

Funding:
$120,000
STIP

Program:
FY2002 Mn/DOT Research Transportation

Rapid Assessment of Distortional Stresses in Multi-Girder Steel Bridges (Phase 3)

Description:
This research, designed to test the applicability of those formulas, shows that they do not predict web gap stresses and diaphragm differentials as accurately as expected.

Conclusions:
A recommendation is made regarding future research on distortional stresses in steel bridges. A class of bridge that may be vulnerable to this problem and which should be considered in future research is the curved girder bridge. These bridges often feature staggered diaphragms, and their geometry is likely to generate measurable differential deflections between adjacent girders that straddle a diaphragm. A field testing program and finite element study of such a curved girder bridge with staggered diaphragms is highly desirable to ascertain if the current assessment procedure for distortional stresses in steel bridges needs to further modification.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.org/pdf/200448.pdf

This project is related to the following projects:
"Monitoring and Assessment Program for (Mn/DOT Bridge No. 79000) at Wabasha over the Mississippi River Phase I." 74708 WO 18

"Remote Monitoring of Distortional Fatigue in Multi-Girder Steel Bridges" 74708 WO 94

"Phase 2 - Analysis Tools and Rapid Screening Data for Distortional Fatigue in Steel Bridge Girders" 74708 WO 177

"Rapid Assessment and Decision Making Strategies for Distortional Fatigue Multi-Girder Steel Bridges - Phase 4" 81655 WO 120

Report #2004-49

Principal Investigator:
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University of Minnesota

CoTechnical Liaison:
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Mn/DOT, Homeland Security

CoTechnical Liaison:
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Mn/DOT,
Metropolitan District

Administrative Liaison:
Jim Aamot,
Mn/DOT

Contract Number:
85575

Contract Period:
August 1, 2003
to February 28, 2005

Funding:
$48,750 Guidestar
$61,250 STIP

Program:
ITS and
Mn/DOT
Transportation
Research Program

Development of Operational Strategies for Travel Time Estimation and Emergency Evacuation on a Freeway Network

Description:
A set of different configurations of the road network, including contra-flow operations, was developed to determine the most efficient evacuation network in terms of the clearance time from the downtown area.

Conclusions:
The application results of the Dynasmart-P model indicate that it's feasible to use a dynamic network assignment model to develop and evaluate evacuation strategies in a large urban network environment. The qualitative testing results with the study network show the possibility of calibrating the model with the data currently available for a given network. The example simulations of different network configurations to evacuate the downtown traffic during an emergency situation indicate that the access capacity to the outbound freeway network is the critical issue in reducing the evacuation time in the downtown area. For example, the effectiveness of the contra-flow operations with the outbound freeway links showed significant improvements when the capacities of the key entrance ramps in the downtown area were also increased. Due to the limitations in the resource and time, a comprehensive analysis was not possible in this study to address various possibilities in terms of network configurations and driver behavior. They include the driver familiarity to the network, route-choice patterns and traffic behavior under emergency situations with/without real-time information, time-delays in configuring network for evacuation and different signal operational strategies. The estimation of the evacuation demand under dynamically changing environment is another important issue that needs to be addressed in the near future.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.org/pdf/200449.pdf

Report #2004-50

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 54

Contract Period:
March 17, 2003 to December 30, 2004

Funding:
$35,000
STIP

Program:
FY2003 Mn/DOT Research Transportation

The Benefits Of Bicycling In Minnesota

Description:
This report represents a first step in trying to ascertain what is known about bicycling in Minnesota, and an initial effort to estimate the sizes of the various types of benefits that bicycling creates.

Conclusions:
This report establishes basic facts about bicycling in Minnesota, and estimates the sizes of the various types of benefits that bicycling creates. There are three main parts to the report. The first uses surveys and data analysis to estimate the amount of bicycling that takes place in Minnesota, and to describe its characteristics. The second part is the development of a theoretical and accounting framework for categorizing and measuring benefits. The third part calculates estimates of the total general benefits of bicycling in Minnesota. Probably about half of adults bicycle at least once in a typical summer. The benefits that result from this riding are large relative to expenditures on bicycle facilities; by our conservative assumptions, total benefits in Minnesota are in excess of $300 million per year. The size of these benefits is particularly notable when one considers that they are derived from relatively limited bicycling by most of the population. We find that the benefits to cyclists themselves are much larger than the benefits to society that bicycling creates, and that recreational riding, due to its much larger volume, creates more total benefits than does utilitarian riding.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.org/pdf/200450.pdf

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Report #2003-01

Principal Investigator:
Eil Kwon, University of Minnesota

Technical Liaison:
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Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 165

Contract Period:
May 30, 2000 to October 31, 2002

Funding:
$48,000 Guidestar
$48,000 STIP

Program:
FY1999 Guidestar Mn/DOT Transportation Research

Signal Operations Research Laboratory For Development And Testing Of Advanced Control Strategies, Phase II

Description:
In this research, a microscopic network simulation model, Vissim, was used to develop a corridor simulation environment with the capacity to model various types of traffic control strategies as external modules. The new stratified Mn/DOT metering algorithm was simulated using the 169 freeway, and its performance was compared with that of the fixed-metering method. The results demonstrate the benefits of reducing overall delay at the ramp-intersection area, while producing higher or compatible total vehicle-miles.

Conclusions:
The major accomplishments of this research include 1) adaptation/application of a microscopic network simulation model for developing a testing environment for ramp metering and coordinated control strategies, 2) development of on/off-line virtual controllers to implement different types of control strategies with the microscopic simulation model, 3) simulation/evaluation of the new Minnesota ramp metering algorithm using the corridor testing environment developed in this study, and finally 4) development/evaluation of a coordinated adaptive control strategy for a ramp-intersection area using the virtual controller-simulator environment. The example applications of the testing environment with the new ramp metering and adaptive coordinated control strategies demonstrated the effectiveness of the microscopic simulation model in evaluating the performance of various control methods prior to field implementation. The simulation of the new ramp metering algorithm has lead to the development of an alternative queue-management strategy in term of determining minimum metering rates.

Implementation:
In this research, a microscopic network simulation model, Vissim, was used to develop a corridor simulation environment with the capacity to model various types of traffic control strategies as external modules. The new stratified Mn/DOT metering algorithm was simulated using the 169 freeway, and its performance was compared with that of the fixed-metering method. The results demonstrate the benefits of reducing overall delay at the ramp-intersection area, while producing higher or compatible total vehicle-miles.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200301.pdf

Report #2003-02

Principal Investigator:
Gene Skok, University of Minnesota

Technical Liaison:
Dan Boerner, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 20

Contract Period:
December 1, 2001 to August 31, 2002

Funding:
$27,596
STIP

Program:
FY2002 Mn/DOT Transportation Research

Asphalt Pavement Analyzer (APA) Evaluation

Description:
This report evaluates the Asphalt Pavement Analyzer (APA) as a tool for assessing the rutting susceptibility of Minnesota Hot Mix Asphalt. Based on a survey of the APA Users' Group and a literature review, its authors recommend that Mn/DOT purchase an APA.

Conclusions:
The literature search has shown that a number of devices have been used to more directly determine the susceptibility of a given mix to rutting; the
1. APA
2. Hamburg Wheel Tracking Device (HWTD)
3. French Pavement Rut Tester (FPRT), and
4. PURwheel

Of these, the APA is the most accepted. It can be used with beam or cylindrical specimens tested under controlled temperature and/or dry or soaked conditions. The results from any of these tests can only be used as an index of rutting susceptibility because the mechanistics of the test procedures can not be easily defined.

Implementation:
Mn/DOT is currently using the APA method and procedures to evaluate mix designs. No measurement has been done of the effectiveness or resulting changes attributed to this implementation.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200302.pdf

Report #2003-03

Principal Investigator:
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Technical Liaison:
Steve Bahler, Mn/DOT

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Number:
74708 WO 60

Contract Period:
January 2, 1998 to January 31, 2000

Funding:
$180,000 Guidestar
$45,000 STIP

Program:
FY1997 Guidestar
FY1998 Mn/DOT Transportation Research

A GPS Based Heads Up Display System for Driving Under Low Visibility Conditions

Description:
This research describes the design, development and evaluation of a Heads Up Display (HUD) system for drivers of ground-based vehicles. A conceptually ideal driver assistance device for low visibility conditions, the HUD projects visual information into the drivers' forward-looking visual field. Results showed that the current system can draw the superimposed images with errors less than 0.5 degrees of visual sight angle while the vehicle moves at various speeds along the test track.

Conclusions:
A conformal HUD to assist drivers by presenting augmented visual information was developed and successfully tested under real driving conditions. The system has now been in operation for some time and has been demonstrated to hundreds of individuals in Minnesota, Indiana (Navistar International, Fort Wayne), and in Ohio (Demo 99 sponsored by ITS America at the TRC in Liberty).

Implementation:
The goals of this research program have been met. An operational heavy vehicle testbed has been developed and various technologies have been tested on it.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200303.pdf

Related Projects:
"Sensing and Control to Enhance the Safety and Driveability of Large Trucks" 71783 WO 132
"A Semitractor Trailer Testbed for the Investigation of Vehicle Guidance" 72444 WO 156
"Sensing and Control to Enhance the Safety of Large Vehicles: GPS" 71783 WO 174
"SAFETRUCK: Sensing and Control to Enhance Vehicle Safety" 74708 WO 2
"Evaluation of Radar for Snowplows" 74708 WO 29
"Driver Assistive Systems for Snowplows" 74708 WO 172
"US DOT IVI Specialty Vehicle Field Operational Test" 74708 WO 160
"Driver Assistive Systems for Rural Applications: A Path to Deployment" INV 774, 81655 WO 16
"User-Centered Auditory Warning Signals in Snowplows" 74708 WO 156

Report #2003-04

Principal Investigator:
Fred Beier, University of Minnesota

Technical Liaison:
Bob Gale, Mn/DOT, Office of Freight and Commercial vehicle Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
74708 WO 182

Contract Period:
January 2, 2001 to February 28, 2002

Funding:
$12,000 OIM—Interregional Corridor
$52,450 STIP

Program:
Mn/DOT Transportation Research Program

The Feasibility of a Shipper Panel to Measure Transportation Services

Description:
This project considers the value of a standing panel of shippers who would contribute carrier evaluation data to a central pool for wider distribution. Based on surveys and focus groups, it concludes that such a panel would be viable and recommends the creation of a pilot project to study implementation issues.

Conclusions:
The objective of this research project was to test the feasibility of the value of a shipper panel of pooled carrier evaluation data. The concept of this system would be a web-based source of evaluation data that would conform to common metrics. Further, data could be easily downloaded to shipper systems. The conclusion is that such a panel appears feasible. The following factors support the conclusion:

- While there are some individual differences by industry groupings, firms see value in pooled carrier evaluation information and are willing to share it. Larger firms, and those controlling multiple facilities, are more likely to see value in such a system. A majority of all firms responded favorably.
- Such a system will add value from the standpoint of adding to the reliability of evaluation data as well as an opportunity to systematize and upgrade existing evaluation processes. This is especially true since many of the existing processes are manual.
- There is no technological barrier for such a system. In general, existing systems would not prevent the use of a web-based, user friendly system that could be downloaded into a spreadsheet or database. The only complication may be for those applications involving in-house systems that may not be compatible with spread sheet technology. Responses indicate that these are a minority of cases.
cases.
- The application of such a system as contemplated here need involve only six or fewer metrics. Currently on-time delivery is the dominant non-cost measure in use.

Implementation:
In this case, implementation of the research has not yet taken place. It is possible, at some point in the future, that a private entity or shipper organization would take on a pilot project, but until that happens, no assessment of implementation impact is possible.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200304.pdf

Report #2003-05

Principal Investigator:
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Technical Liaison:
Dwayne Stenlund, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 139

Contract Period:
October 18, 1999 to April 30, 2002

Funding:
$100,000
STIP

Program:
Mn/DOT Transportation Research Program

Characteristics of Erosion Control Measures and Their Impact on Erosion

Description:
Field study looks at the use of erosion control products on longer slopes and the effects of erosion control blankets on reducing particle shear.

Conclusions:
This project endeavored to expand experimental data on erosion control blankets and develop greater understanding of how blankets and erosion principles interact.

Blankets that are effective in reducing raindrop impact may become ineffective in controlling soil detachment and runoff (rill erosion) on longer slopes.

This field study of erosion control products under artificial rainfall conditions was conducted at the Highway 10 overpass in Coon Rapids, Minnesota. Examining long slope lengths (60 feet and 100 feet), bare soil erosion was compared to erosion under straw blankets, wood fiber blankets, straw mulch, and sprayed emulsion. Measurements of runoff, erosion, and biomass (vegetative growth) were made in spring and fall under wet and dry conditions.

Sediment loads for bare soil were 8 times larger than other treatments. Sediment loads were substantially smaller for the fall runs than the spring runs, largely due to the substantially increased vegetative cover (biomass).

Shear stress partitioning for erosion control blankets was evaluated using a laboratory flume and hot-film anemometry. Erosion control blankets partition shear stress into form shear (the portion that acts on the blanket) and particle shear (the portion that acts on the soil particles). Blanket type, flow conditions, and fastener impacts were considered. Shear partitioning was found to be an important process in design and erosion modeling.

Attempts were made to correlate sediment load and vegetative density data gathered by Texas Department of Transportation (TxDOT) with manufacturer's information on blanket characteristics. However, the data from manufacturers was insufficient to determine patterns or predict performance.
Keywords-erosion control products, vegetation establishment, soil erosion, slope hydrology.

Implementation:
Adding check dams to living bioretention ditches offers a low-cost option to designers for meeting the PCA requirements. As an alternative to building a pond, the savings can be as much as $50,000 in right-of-way costs alone. As a side benefit, implementing the results of peer-reviewed research and making improvements immediately will help road agencies foster trust with the MPCA.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200305.pdf

Related Project:
"Improve the Design of Roadside Ditches to Decrease Transportation-Related Surface Water Pollution" INV 776 74708 WO 198

Report #2003-06

Principal Investigator:
Panos Michalopoulos, University of Minnesota

Technical Liaison:
Linda Taylor, Mn/DOT, Formerly Metro, now Office of Maintenance

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 164

Contract Period:
April 14, 2000 to June 30, 2002

Funding:
$249,608
STIP

Program:
Mn/DOT Transportation Research Program

Employment of the Traffic Management Laboratory (TRAMLAB) for Evaluating Ramp Control Strategies in the Twin Cities

Description:
The Traffic Management Laboratory (TRAMLAB) was used to evaluate the effectiveness of Mn/DOT's control strategy in three Twin Cities freeway sections totaling approximately 65 miles. By developing a new traffic management concept for early detection of incident-prone traffic conditions to smooth flow and prevent incident occurrence, the new strategy aims to reduce delays and improve safety.

Conclusions:
Ramp metering is one way to address freeway traffic congestion. This study employs the Traffic Management Laboratory (TRAMLAB) to evaluate the effectiveness of Mn/DOT's control strategy in three Twin Cities freeway sections totaling approximately 65 miles. It develops a new traffic management concept for early detection of incident-prone traffic conditions and integrates it in order to smooth flow and prevent incident occurrence, thereby further reducing delays and improving safety. The project is part of a larger program which aims to develop the TRAMLAB as part of the ITS Laboratory at the University of Minnesota. Such an environment will contain state-of-the-art traffic simulation programs and allow the development of viable, intelligent, and automated traffic-flow simulation programs and simulation systems that can function as both operational and research tools.

Implementation:
The result of the streamline and automation modeling assessment will provide Metro Division direction and guidance into modeling guidelines, calibration procedures, modeling process, future research and development needs, and training requirements.

Having this additional modeling tool will provide the Metro Division with the capability to model more complex projects. Freeway modeling projects with unique features are currently out-sourced to consultants. The cost of an average modeling project is running between $50,000 and $75,000.

Modeling is used to estimate or predict traffic performance, assess capacity and level of service, and optimize the design and operation of the roadway facility. Our limited resources can be redirected to focus on design and operational improvements by automating labor intensive tasks and streamlining the modeling process.

Mn/DOT's Implementation Funding Program funded a project titled "TRAMLAB Software, Training, and Support" IMP 2003-03 to implement this project.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200306.pdf
http://www.lrrb.gen.mn.us/pdf/200306s.pdf "Summary"

Related Projects:
"Streamlining of the Traffic Modeling Process for Implementation in the Twin Cities Freeway Network - Phase IIa" Contract 81655 WO 94

"Evaluation and Improvement of the Stratified Ramp Metering algorithm through microscopic simulation - Phase IIb" Contract 81655 WO 96

"Employment of the Traffic Management Lab for the Evaluation and Improvement of Stratified Metering Algorithm: Phase IV" Contract 8 1655 WO 176

"IMP 2003-03 TRAMLAB Software, Training, and Support" 2003-019I

Report #2003-07

Principal Investigator:
Andrew Drescher, University of Minnesota

CoPrincipal Investigator:
Henyrk Stolarski University of Minnesota

Technical Liaison:
Richard Larson, Mille Lacs County

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 181

Contract Period:
10/3/2000
to 1/31/2003

Funding:
$39,012 STIP
$123,957 LRRB

Program:
CY2001 LRRB
INV 764
Mn/DOT
Transportation
Research

Investigation of Factors Related to Surface-Initiated Cracks in Flexible Pavements

Description:
This report attempts to provide information on surface stresses that derives from both theory and experiments. It identifies potential mechanisms for the occurrence of top-down cracking, as well as investigates stress patterns and concentrations due to surface load and preexisting transverse (thermal) cracks. Contact mechanics solutions are analyzed to gain information on loads, and three-dimensional computations using the finite element code ABAQUS to illustrate the analysis.

Conclusions:
a single wheel load (pressure) located next to a fully open transverse crack in flexible pavements with and without the presence of transverse (thermal) cracks. Conclusions that can be drawn from this research follow:
1. With the wheel load located next to a fully open transverse crack, there is noticeable change in horizontal and vertical normal stresses in the asphalt concrete and in the base. This change occurs regardless of the thickness and properties of individual layers.
2. Beneath the center of the wheel load, the magnitude of the horizontal compressive normal stresses σyy in the direction perpendicular to the crack decrease at the top of the AC layer. The magnitude of the horizontal tensile normal stresses σyy in the direction perpendicular to the crack at the bottom of the AC layer also decreases. However, the magnitude of the normal stresses σxx at these locations increases in the direction parallel to the crack. Both changes are moderate and depend on asphalt concrete layer thickness and layer properties.
3. The vertical stresses in the base next to the asphalt concrete layer increase in the presence of transverse crack. Significant increase in vertical stresses takes place next to the bottom of the crack. A much smaller increase occurs beneath the center of the wheel load in the base away from the crack.
4. Overall, the magnitude of the horizontal tensile stress σyy at the bottom of the AC layer perpendicular to the crack decreases for all five seasons (different material properties). The most noticeable change in magnitude of stress σyy occurs during the seasons of early spring and winter. On the other hand, the magnitude of the horizontal tensile stress σxx at the bottom of the AC layer parallel to the crack increases for all five seasons. Once again, the most noticeable change in magnitude of stress σxx occurs during the seasons of early spring and winter. The vertical compressive stress in the base increases for all five seasons. A greater increase in magnitude is observed closer to the transverse crack in the base than in the base below the center of loading.
5. As the thickness of the AC layer increases, the magnitude of the stress (both σyy and σxx) decrease. This trend is observed in both uncracked and cracked pavement. The magnitude of the horizontal normal stress σyy at the bottom of the AC layer decreases for all AC layer thicknesses when a crack is present. Conversely, the magnitude of the horizontal normal stress σxx at the bottom of the AC layer increases for all AC layer thicknesses when a crack is present.

Implementation:
Future research to characterize and identify the factors relating to surface-initiated cracks in asphalt pavement will use the results of this study.

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/200307.pdf

Report #2003-08

Principal Investigator:
Cameron Kruse,
Braun Intertec Corporation

Technical Liaison:
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Clearwater County

Administrative Liaison:
Jim Klessig,
Mn/DOT

Contract Number:
78443

Contract Period:
2/24/1999
to 9/30/2001

Funding:
$208,241.44 LRRB

Program:
Implementation of Research Findings
(1999-2000)
INV 645
Task 14

Erosion Control Handbook For Local Roads

Description:
Erosion Control Handbook for Local Roads, covering erosion and sediment control during construction and permanent erosion control. Design, installation, and maintenance techniques are presented for several erosion and sediment control devices. Also includes gravel road maintenance for erosion control projects, regulations for permits, sample erosion control plans, case studies, and outline of records and inspection needs.

Conclusions:
Roadside erosion and runoff is a problem during and after construction. Erosion and the sediment it causes can result in an unhealthy growing environment for vegetation, and can impact waterways in the area. Erosion can also result in additional maintenance and costly repairs.

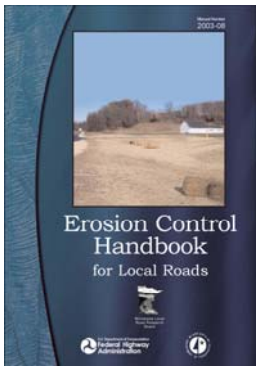
Effective erosion control requires an integrated approach, which considers government statutes and regulations, a broad knowledge of temporary and permanent erosion control methods; design, construction, and maintenance consideration; and new technology. All of those elements are included in this manual.

Implementation:
The Minnesota LTAP Center presented a workshop on "Design and Maintenance Considerations for Erosion Control on Local Roads" on February 17 and March 9, 2004.

The United States Army used techniques from this manual for spring road reconstruction in Afghanistan in 2004.

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200308.pdf



Report #2003-09

Principal Investigator:
Mihai Marasteanu, University of Minnesota

CoPrincipal Investigator:
Gene Skok, University of Minnesota

Technical Liaison:
Bruce Chadbourn, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Number:
81655 WO 10

Contract Period:
9/1/2001 to 2/28/2003

Funding:
$67,869
STIP

Program:
FY2002 Mn/DOT Transportation Research

Dynamic and Resilient Modulus of Mn/DOT Asphalt Mixtures

Description:
This report presents the results of laboratory testing to determine the complex modulus and phase angle of asphalt mixtures from the MnROAD site.

Conclusions:
This report presents the results of laboratory testing to determine the complex modulus and phase angle of asphalt mixtures. Laboratory tests were performed on four different asphalt mixtures from the MnROAD site. Testing was performed at six temperatures and five frequencies. Data from the tests were processed through a nonlinear regression curve fit to generate master curves of dynamic modulus and phase angle vs. frequency. These master curves were compared to results obtained from Witczak's predictive equations.

It was found, as expected, that the dynamic modulus increased with an increase in frequency and a decrease in temperature. The model used to fit dynamic modulus master curves provided a good fit for the experimental data. The modulus values calculated using the 2000 predictive equation fit the test data reasonably well for Cell 21 and 35 mixtures, but the differences for Cells 33 and 34 were more significant. Smooth master curves for phase angle could not be obtained.

An exploratory study to use a vibration exciter to measure dynamic modulus proved unsuccessful. This study was done under the framework of NCHRP Projects 1-37A, 9-19, and 9-29 that recommends dynamic modulus both as a design parameter and a simple performance test. Keywords-complex dynamic modulus, asphalt mixtures, phase angle, master curve.

Implementation:
Mn/DOT will use this information to improve the definition of its MnPAVE software input variables. Results will also aid in the characterization of recycled asphalt mixtures.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200309.pdf

Report #2003-10

Principal Investigator:
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CoPrincipal Investigator:
Andrew Drescher, University of Minnesota

CoPrincipal Investigator:
Jospeh Labuz University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 185

Contract Period:
January 1, 2001 to June 30, 2003

Funding:
$101,554
STIP

Program:
Mn/DOT Transportation Research Program

Enhancements and Verification Tests for Portable Deflectometers

Description:
The accuracy of the stiffness estimate from portable deflectometer devices is investigated, as well as an enhanced setup.

Conclusions:
The key conclusions and recommendations stemming from this research are:
1. PFWD devices such as PRIMA deflectometer constitute an effective and reliable tool for load and deflection measurements. It appears, however, that the traditional data interpretation scheme, so-called peak method, used to estimate the static footing-on-soil stiffness from these measurements, is capable of producing systematic errors and therefore needs to be replaced.
2. In this study, the original data interpretation, based upon peak values, was replaced by a consistent dynamic method in order to estimate the static footing-on-support stiffness using the reaction support offered by the BVT apparatus. The modified data interpretation is based upon spectral analysis and relies on a SDOF analog as theoretical guide. In addition to this first modification, the physical setup of the device itself is also replaced with a simplified, yet enhanced, setup that enables testing with small impact energy. The BVT apparatus proves to be a potentially useful tool for routine verification of the performance of PRIMA 100 devices.
3. Furthermore, similar enhancements of PRIMA device for field-testing situations can be investigated. In that case, the spectral-based data interpretation should incorporate an adequate theoretical model (such as the footing-on-a-layered-half-space model, and replace the SDOF analog used for the beam).
4. For quality assurance purposes, field in which stiffness estimation focuses on the top layer of pavement profiles, the enhanced physical setup presented in this study is recommended. In addition to the advantage of offering a shallower depth of investigation (compared to that associated with the original falling weight setup), the use of the enhanced setup aims toward the estimation of the seismic modulus, comparable to that stemming from geophysics investigation methods.

Implementation:
Mn/DOT's Implementation Funding Program funded the project "Resilient Modulus Testing Following LTPP P-46 Protocol" 81655 WO 32

Implementation Outcome:
No Close-out Memo was written. Another Implementation Plan was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200310.pdf

This projects relates to:
"Moisture Effects on DCP and PFWD Measurements - Phase I (CTS FUNDED)" 2001-062P
"Moisture Effects on DCP and Portable Vibratory Deflectometer (PVD) Measurements - Phase II" Contract 81655 WO 57
"Resilient Modulus Testing Following LTPP P-46 Protocol" Contract 81655 WO 32
"Implementation of Enhanced PFWD Recommendations" Contract 87803

Report #2003-11

Principal Investigator:
Jerry Geib, Mn/DOT, Office of Materials

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract Number:
N/A

Contract Period:
N/A

Funding:
MnROAD

Program:
MnROAD

Saw and Seal Repair - Chisholm/Hibbing Airport Taxi

Description:
Field report on the repair of sawed and sealed joints at Chisholm-Hibbing Municipal Airport. A hot pour transverse patch material is evaluated.

Conclusions:
The Chisholm- Hibbing Municipal Airport completed taxiway repairs, of deteriorated sawed and sealed joints on August 6-8, 2001. This report documents the construction procedures, techniques, and materials used. A field review was completed on January 24, 2002. This report also documents the initial performance of the repairs. Transverse thermal cracking, followed by the deterioration of the hot mix asphalt at the crack is a major problem in Minnesota. The pavement between the cracks is often in good condition. The area within one foot of the crack begins to strip and collapse inward/downward. It also can tent up in the winter due to freezing moisture in the crack area. Both situations require repair. Long-lasting, cost-effective repairs at the cracked areas are needed.
The hot pour, transverse patch material is a newer material that is fast, economical and durable. This material has the potential to be widely used for transverse crack repair on airports and roads in the state of Minnesota. This report focuses on the hot pour transverse patch material.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200311.pdf

Report #2003-12

Principal Investigator:
Henryk Stolarski, University of Minnesota

Technical Liaison:
Eric Wolhowe, Mn/DOT, Office of Bridges

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Number:
74708 WO 65

Contract Period:
November 10, 1997 to February 28, 2001

Funding:
$104,000
LRRB

Program:
CY1998 LRRB
INV 730

The Effect of Transverse Stiffener Beams On Shear Transfer

Description:
An investigation of the use of Transverse Stiffener Beams (TSB) for use on new and existing wooden bridges to reduce deformations of bridge decks, thus prolonging the life of asphalt bridge coverings, was undertaken. Positive effects of TSBs should be expected in other applications and can be analyzed with a computer program developed by this project.

Conclusions:
The goal of this study was to determine if the use of TSBs on an LNL deck would improve load-sharing across the deck width and ultimately decrease both total and differential deflections. In all cases, the attachment of the midspan TSB had a beneficial effect on the deck response reflected in a decrease of both total and differential deflections. However, the magnitude of these effects varied across the deck width and, to some extent, along its length. The outer edges of the deck benefited the least from the TSB, while the center timbers of the deck experienced the greatest benefit. Furthermore, the TSB was actually more effective in reducing deflections on the deck after it had been subject to cyclic loading. The difference was not very significant, though.

Implementation:
Specifications for laminated bridges were modified to require that the moisture content at the time of construction needed to be less than 19%. For existing bridges, the annual inspection routine was modified to include load testing the post tensioning system.

In August of 1999, a survey was sent to county engineers who received reports 1998-07, 1998-07S, and 1999-03 in order to measure the usefulness of the research and any benefits derived. The Mn/DOT Bridge Office said two main points come out of this research that they will focus on. First, in regards to Transverse Stiffener Beams, the code used to design timber bridges changed and it now requires more transverse stiffener beams. This change coincides with what the research suggests. The Bridge Office notified the consulting firm that designs most of the timber bridges for the county system. Second, in regards to Moisture Content, the Bridge Office discussed this with the consulting firm previously mentioned and they are working on ways to insure the lower moisture content. The current Mn/DOT specification requires a maximum of 19 percent, but this standard is not always met.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200312.pdf

Related Reports:
LRRB INV699 "Timber Bridge Inspection" 71391 WO 126 Report #2002-34
LRRB INV706 "Evaluation of Timber Bridge Wear Surfaces" 74708 WO 8 Report #1998-07
LRRB INV731 "Equilibrium Moisture Content of Wood in Minnesota Timber Bridges" 74708 WO 66 Report #1999-03
LRRB INV694 "Cold Temperature Effects on Stress Laminated Bridge Decks" 71263 WO 121 Report #1998-03
LRRB INV687 "Analysis of The Bridge Retrofit System Developed by Gene Isackson" 68575 WO 66 Report #94-16
LRRB INV709 "Evaluation of Retrofit Procedures for Nail-Laminated and Stringer Bridges" 73596 WO 191 Report #2002-28

Report #2003-13

Principal Investigator:
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CoPrincipal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 142

Contract Period:
April 1, 2000 to June 30, 2002

Funding:
$401,026
Pooled Fund

Program:
Pooled Fund

Driver Assistive Systems for Snowplows

Description:
Research on the use of a specialized driver assistance system to assist specialty vehicle operators in low visibility conditions, including the design of a custom Head Up Display (HUD) projecting elements of the landscape in proper perspective. Driver assistive displays, the integration of a geospatial database for improved radar processing, snowplow dynamics for slippery conditions, and a virtual bumper based on collision avoidance/gang plowing system are discussed.

Conclusions:
A comprehensive driver assistive system which utilizes dual frequency, carrier phase real time kinematic (RTK) differential global positioning system (DGPS), high accuracy digital geospatial databases, advanced automotive radar, and a driver interface with visual, haptic, and audible components has been used to assist specialty vehicle operators perform their tasks under these low visibility conditions. The system is able to provide a driver with high fidelity representations of the local geospatial landscape through a custom designed Head Up Display (HUD). Lane boundaries, turn lanes, intersections, mailboxes, and other elements of the geospatial landscape, including those sensed by automotive radar, are projected onto the HUD in the proper perspective. This allows a driver to safely guide his or her vehicle in low to zero visibility conditions in a desired lane while avoiding collisions. Four areas of research, are described herein: driver assistive displays, the integration of a geospatial database for improved radar processing, snowplow dynamics for slippery conditions, and a virtual bumper based collision avoidance/gang plowing system. (Gang plowing is the "flying in formation" of snowplows as a means to rapidly clear multilane roads.) Results from this research have vastly improved the performance and reliability of the driver assistive system.

Implementation:
First, development of the baseline snowplow technologies led to the award of the multi-million dollar Intelligent Vehicle Initiative to evaluate the Driver Assist System technologies in multiple vehicle types. Secondly, the successful demonstrations of the technology at a few national conferences increased and solidified Mn/DOT and University of Minnesota reputations as technology leaders in Intelligent Transportation Systems research. Additional impacts may be assessed at a later date depending on the outcome of Implementation Project No. 2000-002I mentioned above.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200313.pdf

Report #2003-14

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
John Scharffbillig, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Number:
74708 WO 156

Contract Period:
March 9, 2000 to June 30, 2003

Funding:
$25,000 Guidestar
$25,000 STIP

Program:
FY1999 Guidestar
FY2000 Mn/DOT Transportation Research

The Effectiveness of Auditory Side- and Forward-Collision Avoidance Warnings in Winter Driving Conditions

Description:
A driving simulation experiment was conducted to investigate auditory icons as side- and forward-collision avoidance warnings. The auditory warnings produced significantly faster mean response times than with no warning, and participants preferred a double-beep side collision warning over a single-beep warning. Researchers recommend a double-beep auditory warning similar to the double-beep of a car horn for side-collision avoidance and a forward-collision avoidance warning similar to two successive bursts of screeching tires.

Conclusions:
The current study confirms the suggestion made by Belz et al. that auditory icons are excellent candidates for use as warning signals (13). We extended their finding by comparing different configurations of auditory icons for both side- and forward-collision avoidance warnings. As a result of this study, we suggest that:

- An auditory icon that is the double-beep of a car horn should be used as a side-collision avoidance warning.
- An auditory icon that is the sound of two short bursts of screeching tires during emergency braking should be used as a forward-collision avoidance warning (with a higher frequency mix than was used in this study).

Implementation:
If implemented, the double-beep side collision-avoidance warning is expected to be useful to snowplow operators and should reduce the frequency of side-collision crashes. Further research is needed before recommendations regarding the implementation of the forward collision-avoidance warning can be made.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200314.pdf

Report #2003-15

Principal Investigator:
Kathleen Harder, University of Minnesota

CoPrincipal Investigator:
Peter Hancock, University of Minnesota

Technical Liaison:
Greg Isakson, Goodhue County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 175

Contract Period:
August 10, 2000 to July 31, 2003

Funding:
$67,203
LRRB

Program:
CY2000 LRRB
INV 760

Reducing Crashes at Controlled Rural Intersections

Description:
A driving simulation experiment was conducted to research interventions to right-angle crashes at rural Thru-STOP intersections, which accounted for 71% of Minnesota fatal crashes in 1998, 1999, and the first half of 2000. The interventions caused drivers to reduce speed as they neared the intersection, and implies that 1) drivers are less likely to inadvertently run stop signs when slowing down further from the intersection, 2) making the intersection more noticeable improves driver safety judgment, and 3) speed reductions on the major road of an intersection produce greater reductions in stopping distances.

Conclusions:
The emphasis of this project was on a preliminary investigation of mitigating strategies intended to reduce crashes at controlled rural intersections. A Human Factors analysis of a problem intersection was conducted. The intersection had sight-lines problems. These were addressed with interventions to the infrastructure that were tested in a driving simulation experiment. This driving simulation experiment explored the effect on driving behavior of implementing several interventions aimed at increasing the saliency of a rural intersection in Goodhue County, Minnesota. The results of the experiment revealed that:
• After the intervention, on the minor road the participants began to reduce speed further away from the intersection.
• After the intervention on the major road, 20% of the participants in the After Condition (those in the Slow After Group) reduced their speed by an average of 44% on the approach from the North. All participants in the After Condition reduced their speed by an average of 11.8% on the approach from the South. For both approaches, the reductions in speed would be likely to translate into considerable reductions in stopping distance in the event that a vehicle pulled into the intersection from the minor road and required an emergency stop from the driver on the major road. Given the relatively low traffic volume on TH-58, reductions in speed are not likely to result in rear-end crashes.

Implementation:
Results of this study will be used in future research on safety at rural intersections. No impacts have been identified to date.

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/200315.pdf

Report #2003-16

Principal Investigator:
Robert Dexter, University of Minnesota

Technical Liaison:
Kevin Anderson, Mn/DOT, Metro District

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 135

Contract Period:
December 1, 1999 to May 31, 2002

Funding:
$280,000
STIP

Program:
Mn/DOT Transportation Research Program

Effects of Increasing Truck Weight on Steel and Prestressed Bridges

Description:
Eight bridges were tested in this report to try to shorten the time needed for repair or replacement.

Conclusions:
Any increase in legal truck weight would shorten the time for repair or replacement of many bridges. Five steel girder bridges and three prestressed concrete I-girder bridges were instrumented, load tested, and modeled. The results were used to assess the effects of a 10 or 20% increase in truck weight on bridges on a few key routes through the state. Essentially all prestressed girders, modern steel girders, and most bridge decks could tolerate a 20% increase in truck weight with no reduction in life. Unfortunately, most Minnesota steel girder bridges were designed before fatigue-design specifications were improved in the 1970's and 1980's. Typically, an increase in truck weight of 20% would lead to a reduction in the remaining life in these older steel bridges of up to 42% (a 10% increase would lead to a 25% reduction in fatigue life). Bridge decks are affected by axle weights rather than overall truck weights. Transverse cracks in bridge decks are primarily caused by shrinkage soon after construction and are not affected by increasing axle weight. However, decks with thickness less than 9 inches or with girder spacing greater than 10 ft may be susceptible to longitudinal flexural cracking which could decrease life.

Implementation:
Some of the information needed to do a comprehensive assessment of bridges in Minnesota is already included in a database, the Bridge Management System (BMS) used by the Bridge Office to monitor bridge maintenance and inspection. With the input of additional key design criteria into the BMS (for example, cover plate details and diaphragm connection details), bridge engineers will be able to extrapolate and summarize the impacts of increasing truck weights on the entire bridge system. The additional needed information is shown on the original bridge plans but has never been recorded into the BMS system.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200316.pdf

Related Projects:
Implementation project "Effect of Increasing Truck Weight on Steel and Prestressed Bridges Summary/Communications" 2004-054C

"Evaluation and Analysis of Mn/DOT Steel Bridges Inventory for Prioritizing Bridge Maintenance Needs" Contract 81655 WO 170

Report #2003-17

Principal Investigator:
Vaughan Voller, University of Minnesota

Technical Liaison:
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Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 174

Contract Period:
August 2, 2000 to June 30, 2003

Funding:
$75,000
LRRB

Program:
CY2000 LRRB
INV 757

Designing Pavement Drainage Systems: The MnDRAIN Software

Description:
MnDRAIN refers to a Microsoft Excel spreadsheet embedded with computer codes to investigate the consequences of edge drain design. MnDrain offers free access to all source codes and can be reconfigured to deal with a large array of pavement drainage issues. A full copy of the MnDrain code, including all source programs and an on-line manual, can be downloaded on visiting http://www.ce.umn.edu/~voller/ voller_research/task5/mndrainrequest.html.

Conclusions:
MnDrain allows for evaluation of a given drain design against the FHWA requirement. In MnDrain the user can Choose from three basic scenarios. Select material types and adjust geometries for each scenario. Calculate the moisture removal vs. time curve over a two-hour drainage time for comparison with the FHWA 85% cut off.

Implementation:
A training session was held for Mn/DOT staff in December of 2002. Surveys collected after the training on the software clearly indicated that there is little interest in using this program. Mn/DOT is focusing on a more accurate and more representative approach to pavement drainage, a mechanistic approach that relates drainage to material strength and stiffness, which is also the approach taken at the national level.

As a result of the implementation, Mn/DOT has determined to focus on using the SEEP/W software for pavement drainage modeling.

Implementation Outcome:
Results not useable

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200317.pdf

Report #2003-18

Principal Investigator:
Robert Dexter, University of Minnesota

Technical Liaison:
Erik Wolhowe, Mn/DOT, Office of Bridges

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
81655 WO 13

Contract Period:
September 1, 2001 to June 30, 2003

Funding:
$95,000 Consultant Services

Program:
FY2002 Mn/DOT Transportation Research

Fatigue Evaluation of Steel Box-Girder Pier Caps: Bridge 69832

Description:
The cause and significance of the fatigue cracks in the steel pier caps of Bridge 69832 were determined, and the effectiveness of several alternative repair schemes was assessed. A description of the fatigue cracking, a review of fatigue design practice, a detailed inspection, and the mechanism behind the high stress ranges are included. Proposed recommendations and retrofits for addressing the fatigue problems are covered.

Conclusions:
Bridge 69832 is a critical link in the flow of traffic heading into Duluth. Fatigue cracks have occurred in the fracture-critical steel pier caps with integral girders. A variety of sensors were installed at various locations near pier cap 5. Finite-element models were developed that agreed well with the measurements. It was confirmed that the cracks are due to torsion of the pier caps due to different girder end moments under traffic loading. As the rectangular cross section distorts, high stress ranges occur at the corners. The location of the high stress ranges is dependent on the detail inside the pier cap. None of these cracks are presently a threat to the structural integrity of the pier caps. Most of the cracks are limited to the welds and will eventually arrest as they grow larger with minimal structural consequences. Therefore the recommendation for these cracks is to inspect them carefully every two years and not repair them. However, on the north side at Girder D of Pier Cap 9, the cracks are presently in the web plates of the pier caps and these must be repaired as soon as possible. Since there are three different crack types that have occurred, the recommendations for each are slightly different.

Implementation:
Bridge engineers had been anticipating a complicated procedure to fix the problem with the pier cap on Bridge 69832. The research confirmed that the initial remedial repair method was adequate and that no further actions were needed. Due to the research findings, Mn/DOT avoided an expensive, time-consuming repair project. Bridge Office managers now have increased confidence in this repair method and it is being used routinely. Research also confirmed precise locations where the testing instruments should be placed in order to ensure accurate readings in the future. The improved method for instrumentation will result in better research.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200318.pdf

Report #2003-19

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Number:
74708 WO 149

Contract Period:
February 23, 2000 to May 31, 2003

Funding:
$41,698
COPTRS

Program:
Mn/DOT Transportation Research Program

The Per-Mile Costs of Operating Automobiles and Trucks

Description:
This Mn/DOT report describes a methodology and spreadsheet model for use in benefit-cost analysis of highway projects by calculating the variable costs of operating cars and trucks.

Conclusions:
In a "baseline" case of highway driving on smooth pavement, with a gasoline price of $1.50 per gallon, that personal vehicles average 17.1 cents per mile to operate, and trucks average 43.4 cents per mile. City driving conditions, involving frequent stops and starts, increase this cost by 3.9 cents per mile for personal vehicles and 9.5 cents for trucks. Extremely rough pavement increases the baseline cost by 2.7 cents for personal vehicles and 5.5
cents for trucks.

Implementation:
Mn/DOT Office of Investment Management (OIM) is using the results of this research, along with national figures and new values in the AASHTO "red book," to update the Mn/DOT values used for calculating vehicle operating costs resulting in more accurate estimates.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200319.pdf
http://www.lrrb.gen.mn.us/pdf/200319S.pdf (Spreadsheet)

Report #2003-20

Principal Investigator:
Iris Charvat, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 153

Contract Period:
January 18, 2000 to July 31, 2003

Funding:
$150,000 STIP

Program:
Mn/DOT Transportation Research Program

The Effects of Fire Versus Mowing on Prairie Plant Communities

Description:
The effects of burning, mowing and haying on the vegetative community, the mycorrhizal fungal community, and the soil parameters of restored prairie are assessed, with the goal of reducing the need for prescribed burning. Haying is found to be a sufficient practice to replace prescribed burning at many sites.

Conclusions:
The primary goals of this project are to discover management processes which benefit a restored prairie and reduce the need for prescribed burning. Moreover, because of the interdependence of the plants and soil, there is a strong focus on the soil community as a driving force of the vegetation. Consequently, our objectives were to assess the effects of manipulation (burning, mowing) on: (1) the vegetative community, (2) the belowground mycorrhizal fungal community, and (3) on soil parameters.

Prescribed burning has the strongest effects on plant community composition and is the most effective method to increase aboveground plant biomass in a restored tallgrass prairie. Burning especially favors warm season grasses (WSG) and legume species, though it also favors certain annual species. Spring haying is an acceptable alternative to spring burning, though its effects are less dramatic than the burn. In particular, haying does not favor WSG as extensively and may not damage cool-season species as thoroughly as burning. Adding lime to hayed prairie may help benefit the cool-season plants, native and exotic. However, utilizing mowing instead of burning probably does not differ much from leaving the prairie untreated.

The process of removing litter seems to be the most important cause of the ecosystem response to prescribed burning. Hayed plots are the most similar to burned plots in terms of soil moisture, temperature, and litter quantity. Hence, litter removal by haying will likely be a sufficient practice to replace prescribed burning at many sites.

Implementation:
There are no current plans to measure the impacts of implementation. A cost comparison could be made for time and personnel requirements to maintain roadsides with burning vs. haying. These numbers could then be used to calculate cost savings on those roadsides already planted with native species. Another comparison could be made by illustrating the difference in maintenance costs for non-native species vs. native species in roadside plantings to encourage the use of restored roadside prairies. However, given the current budget constraints and staffing issues at Mn/DOT, there are no resources available to design and conduct this type of evaluation.

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/2003.pdf

Report #2003-21

Principal Investigator:
William Gartner, University of Minnesota

CoPrincipal Investigator:
Daniel Erkkila, University of Minnesota

Technical Liaison:
Mark Anderson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 76

Contract Period:
March 16, 1998 to December 31, 2000

Funding:
$119,995
STIP

Program:
Mn/DOT Transportation Research Program

Barriers to Increasing Minnesota's Share of the International Tourist Market

Description:
A multi-method investigation of barriers that prevent international visitors from traveling to and within Minnesota. Tourism products and marketing ideas for overseas markets are presented.

Conclusions:
A number of recommendations can be offered based on the findings from this multi-method investigation of barriers preventing international visitor growth. They are derived from the discussion throughout this report. However, not all barrier reduction strategies should be expected to have the same effect on different nationalities. As previously mentioned, only the German long haul market was subjected to a barrier reduction survey. Other nationalities may see some of the barriers, not significant for the German market, to be highly significant in their own culture. Therefore, before barrier reduction strategies are employed, the target market should be identified and tests for barrier resiliency should be performed on those markets. With that caveat in mind recommendations for barrier reduction follow.

Implementation:
Implementation would be difficult as it will require a great deal of private/public cooperation which has yet to materialize. Mn/DOT thinks it would be more appropriate for the Metropolitan Airport Commission (MAC) to follow up on this issue since they are also working on projects to maximize the use of regional airports. One recommendations to Mn/DOT from the report t is to "continue support of intermodal transportation, especially high-speed options to primary tourist attractions and destinations, both within Minnesota and to Greater Minnesota destinations", which is being done.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200321.pdf

Report #2003-22

Principal Investigator:
William Gartner, University of Minnesota

CoPrincipal Investigator:
Daniel Erkkila, University of Minnesota

Technical Liaison:
Mark Anderson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 116

Contract Period:
May 10, 1999 to March 31, 2002

Funding:
$154,000
STIP

Program:
Mn/DOT Transportation Research Program

Attributes and Amenities of Minnesota's Highway System That Are Important to Tourists

Description:
Exploratory study utilizing a user survey to address travelers' preference for physical characteristics and amenities on eleven road segments in Minnesota. Scenic and environmental qualities were highly valued characteristics, and many travelers prefer commercial-free corridors.

Conclusions:
This was an exploratory study looking at users preference for various roadway attributes and amenities. A great deal of information is contained in this report allowing management for road segments selected for study to be decided on a case-by-case basis. There is enough difference exhibited by users of different road segments to state that roads do possess individual character that is considered in the road selection process, with the expectation that travel on them will provide certain benefits.

Implementation:
The research suggests that project managers may want to perform similar consumer research on a highway segment prior to project scoping to determine customer expectations for that particular roadway. This research may support certain design features in a highway project and it may also defend decisions to not include certain design features in a project because they are not consistent with user expectations for that highway.

Mn/DOT plans to hold focus groups of project managers to determine what project managers need to know about highway attributes and aesthetics to help define future research needs. Additional research is needed to quantify the value of aesthetic attributes and to provide tools for project managers to make decisions on aesthetic elements and justify expenditures for these attributes.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200322.pdf

Report #2003-24

Principal Investigator:
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Technical Liaison:
Jerry Geib, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract:
81655 WO 18

Contract Period:
10/8/2001 to August 31, 2003

Funding:
$40,487 LRRB

Program:
CY2001 LRRB INV 779

Evaluation of Asphalt Binders Used for Emulsions

Description:
Asphalt emulsions typically used in cold in-place recycling (CIR) applications were tested, and a sample mix design is presented using these emulsions and an empirical equation to predict the dynamic modulus of the mixture.

Conclusions:
The results presented in this study should be viewed as a first step in the development of a comprehensive performance base CIR material selection specification. The research performed in this study demonstrates the possibility of adapting the current PG test protocols and analyses to asphalt emulsion characterization. This approach offers the advantage of comparing conventional asphalt binders and asphalt emulsions based on a similar set of test protocols. However, extensive well-documented field data, which was not available at the time of this research project, is required to develop meaningful correlations between the experimental data and the actual performance of CIR mixtures. In addition, a study of the interaction between the RAP and the asphalt emulsion should be performed to better understand the role of the RAP binder in the CIR mixture performance as well as the asphalt emulsion mixing and setting characteristics. With respect to the pavement design aspect of CIR, extensive experimental data performed on laboratory prepared CIR mixtures will be required to validate and eventually modify the predictive equation developed as part of the 2002 Design Guide, that was used in chapter 4 to predict the complex dynamic modulus of a typical CIR mixture.

Implementation:
The information will be used as researchers continue to characterize asphalt emulsions. No impacts are identified as of this date.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200324.pdf

Report #2003-25

Principal Investigator:
Vaughan Voller, University of Minnesota

Technical Liaison:
Roger Olson, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
70361 WO 100

Contract Period:
December 15, 1992 to November 14, 1995

Funding:
$34,425
LRRB

Program:
CY1993 LRRB
INV 690

Progressive Lifting of Shallow Sewers: Field Investigation

Description:
To develop local expertise in the numerical modeling of ground freezing and thawing. To develop validated numerical codes that can be used to investigate specific situations relevant to transportation systems.

Conclusions:
Towards developing an understanding of how thawing and freezing cycles impact transportation infrastructure there are significant advantages in building a lumped 'macro-scale' model, especially when dealing with two- or three-dimensional problems, where it is extremely difficult to measure microprocess parameters (e.g. ice velocity and its direction). This work has shown that a lumped porosity model can generates accurate comparison with experiments and is feasible in gaining insights into the effect of freeze thaw on buried infrastructure. It is recommended that further work is undertaken to develop user friendly software based around the lumped porosity model and thereby extend its application across a wide range of transportation infrastructure problems. In the mean time it is recommended that practical construction methods and non frost susceptible materials be utilized, see Svec and Gallagher (2002). A synthesis of innovative construction practices should also be completed.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200325.pdf

Report #2003-26

Principal Investigators:
Roger Olson and Ruth Roberson, Mn/DOT, Office of Materials

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
MnROAD

Program:
MnROAD

Edge-Joint Sealing as a Preventative Maintenance Practice

Description:
Sealing the edge joints on concrete pavements with bituminous shoulders reduces the volume of water entering the pavement system by as much as 85 percent. Longitudinal edge joint sealing should be considered as a pavement preventive maintenance treatment.

Conclusions:
Preventive maintenance treatments such as joint sealing are part of ongoing research at the Minnesota Road Research test facility. Pavement sections at the test facility are instrumented extensively, thus providing automated measurements of changes in pavement moisture and drainage due to varying climate conditions. Joint sealing studies involve measuring changes in edge drain outflow and base moisture content in response to precipitation events. Concrete test sections and longitudinal edge drains were constructed. Data was collected before and after edge joints were sealed on concrete sections. There was no significant difference in the volume drained between the control and the test section prior to sealing the joint on the test section. After sealing the edge joint, there was a significant reduction in the volume drained from the test section. Sealing the edge joint on concrete pavements with bituminous shoulders is shown to reduce the total volume of water entering the pavement system by as much as 85% for a given rain event. Sealing the longitudinal edge joint on concrete pavements should be considered as a pavement preventive maintenance treatment.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200326.pdf

Report #2003-27

Principal Investigator:
Eil Kwon,
University of Minnesota

Technical Liaison:
Bob Betts,
Mn/DOT

Administrative Liaison:
Jim Aamot,
Mn/DOT

Contract:
81655 WO 3

Contract Period:
February 4, 2002 to July 31, 2003

Funding:
$92,800 Guidestar
$23,200 STIP

Program:
FY2002 Mn/DOT Transportation Research

Development of Dynamic Route Clearance Strategies for Emergency Vehicle Operations, Phase I

Description:
The best route for an emergency vehicle was selected on-line, then traffic signals were dynamically and sequentially preempted to clear traffic for the emergency vehicle. This route-based method may increase the speed and safety of emergency vehicles compared to using the intersection-by-intersection preemption method.

Conclusions:
This report presented a route-based dynamic preemption method for emergency vehicles and its evaluation results in an example network using a microscopic simulation model. The proposed strategy sequentially preempts the traffic signals at the intersections along the optimal route with advance activation, so that the traffic queue at each intersection can be cleared for the approaching emergency vehicle. Due to the limitations of the simulation software, the on-line route-selection method developed in this study could not be tested in the current phase. The evaluation results with pre-specified emergency routes show substantial reduction of the emergency vehicle travel time for relatively long and/or complicated routes compared with the existing intersection-by-intersection preemption method, while the magnitude of the benefit can vary significantly depending on the length and type of the route. Further, the network-wide performance measures with the proposed dynamic preemption method were very compatible with those from the existing intersection-by-intersection clearance method. The performance comparison between single and variable-point activation indicates no significant advantage with the more complicated variable point method, which implies the practical applicability of the proposed simple activation strategy.

Implementation:
None at this time, but the benefits of quicker emergency vehicle responses is easy to imagine.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200327.pdf

Report #2003-28

Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Dave Rettner, Mn/DOT

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 91

Contract Period:
June 29, 1998 to March 31, 2002

Funding:
$126,716 STIP

Program:
Mn/DOT Transportation Research Program

Refinement and Validation of the Hydraulic Fracture Test

Description:
Report describing the results of recent improvements to the Washington Hydraulic Fracture Test for concrete aggregate freeze-thaw durability. The test is believed to now be ready for validation testing and eventual wide-spread acceptance and implementation as an accurate tool.

Conclusions:
The Washington Hydraulic Fracture test was developed under the Strategic Highway Research Program to address the need for a rapid, inexpensive test for concrete aggregate freeze-thaw durability. The original test and analysis procedures were not sufficiently reliable and accurate to merit widespread adoption and implementation. Several follow-up research efforts have been performed and each has resulted in improvements to the test. This report describes the results of recent research efforts to improve the test. The "hydraulic fracture index" has been replaced by a model that predicts freeze-thaw test dilation as a function of the distribution of particle mass retained on various sieves after testing. This model was developed using data obtained from freeze-thaw and hydraulic fracture testing of 18 quarried carbonate and gravel aggregate sources, and the resulting correlation is exceptional (r-squared = 0.98). In addition, a large test chamber was developed to allow testing of aggregate samples five times larger than the original small chamber, thereby allowing aggregate durability characterization with a single test run. It is believed that the hydraulic fracture test is now ready for more broad-based validation testing and eventual widespread acceptance and implementation as an accurate screening tool for concrete aggregate freeze-thaw durability.

Implementation:
Mn/DOT's Implementation Funding Program funded a project titled "Refinement and Validation of the Washington Hydraulic Fracture Testing Specification/Training" IMP 2005, Proposal No. 4

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200328.pdf

Report #2003-29

Principal Investigator:
Alfred Marcus, University of Minnesota

Technical Liaison:
John Tompkins, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 187

Contract Period:
January 1, 2001 to June 30, 2003

Funding:
$25,000 Center for Transportation Studies
$54,000 Pooled Fund

Program:
2001 SP&R SPR-3(100)

ISO 9000's Effects on Accident Reduction in the U.S. Motor Carrier Industry

Description:
This report aims at establishing a correlation between the voluntary ISO 9000 certification by motor carriers and traffic safety. Through quantitative analysis, the authors have come to believe that quality assurance directly impacts the safety performance of a motor carrier organization which in turn improves the financial performance.

Conclusions:
and that management practices and tools commonly used for improving operating and quality performance helped improve safety performance. Financially well-to-do organizations were safer, yet whether an organization was financially well off or not, it could achieve a better safety record if it adopted a management practice like ISO 9000. Our analysis suggests that the effects of financial performance on safety are partially mediated by the management practices an organization adopts. Management practices implemented because organizations have better financial performance result in companies that have better safety records. Because evidence for this relationship has not been previously established in the literature, we believe that our study makes an important contribution.

Implementation:
The analysis suggests that the effects of financial performance on safety are partially mediated by the management practices an organization adopts. Management practices implemented because organizations have better financial performance result in companies that have better safety records. Since evidence for this relationship has not been previously established in the literature, the authors believe that their study makes an important contribution.

The overriding implication of this study is that in order to improve motor carrier safety and reliability as well as avoiding traffic accidents that can cause deaths and injuries, quality standards like ISO 9000 are useful.

According to the authors, this study is the first solidly based research exploring and comparing the safety and financial performance of ISO 9000-certified and non-certified motor carriers companies before and after certification. The researchers examined and identified the conditions under which ISO 9000 is likely to have a positive effect on carrier safety. Understanding the connection between a better quality assurance system and safety performance in this industry should provide guidance to regulators, shippers and firms in the industry.

The ISO 9000 quality assurance standard can have a positive effect on both financial and safety performance. With ISO 9000 in place, motor carrier regulators can feel more confident that a carrier is likely to exhibit good driving practices and have fewer accidents. This study also can serve to develop shipper awareness of the link between certification and safety. Inasmuch as this study helps to define a modern quality assurance system for the trucking industry as a tool for increasing safety, its implications are very broad.

An idea expressed by the main author of the research report, Eitan Naveh, is whether or not a voluntary system can be used instead of a regulatory one. If it can be shown that the use of an ISO 9000 standard can benefit a motor carrier company financially, the incentive to use it is there. Questions remain. The authors recommend further research to investigate the circumstances under which ISO 9000 and other programs for upgrading motor carrier performance help lead to increases in safety.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/2003.pdf

Report #2003-30

Principal Investigator:
David Forkenbrock, University of Iowa

Technical Liaison:
Ken Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
79075 WO 1

Contract Period:
July 19, 1999 to April 30, 2002

Funding:
$338,114.50
Pooled Fund - MnROAD

Program:
2002
SP&R
SPR-3(071)

A New Approach to Assessing Road User Charges

Description:
A new road user charge system based on an actual miles traveled basis, or vehicle miles of travel (VMT), is recommended to replace motor fuel taxes, which are in jeopardy due to new vehicle propulsion technologies. This charge would provide a means for crediting states or sub-state jurisdictions for the miles of travel occurring within their boundaries by collecting data from vehicles equipped with intelligent vehicle and GPS technologies. Researchers conclude that a convenient and flexible road user charge system can be designed which will ensure a stable source of revenue for the highway system.

Conclusions:
The best approach to assessing road user charges is one that is based on the actual mileage traveled. It is essential that there be a means for crediting the state (or substate jurisdiction) for the miles of travel occurring within it. With a VMT user charge, an individual state can tailor the per-miles rates to pursue equity and efficiency objectives as well as to encourage environmentally friendly vehicles and travel on appropriate roads (e.g., for heavy vehicles to use roads capable of supporting their axle loads).

Implementation:
As long as fuel consumption is expected to decrease due to more fuel-efficient and/or less fuel-dependent vehicles, transportation agencies will need to consider alternative approaches to funding transportation costs. Any proposals for change will need to be supported by solid research, operational field tests and support from high-level policy experts.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200330.pdf

Related Project:
"A New Approach to Assessing Road User Charges (Task 5) SP&R-3(071)" 74708 WO 126

Report #2003-31

Principal Investigator:
Lee Munnich, University of Minnesota

CoPrincipal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Ken Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 151

Contract Period:
January 4, 2000 to February 28, 2003

Funding:
$973,750
STIP
(Federal Reimbursed)

Program:

Minnesota Value Pricing Project

Description:
Value pricing project report, funded by the Federal Highway Administration (FHWA) to continue previous work. This project included major components of both national outreach and continuing efforts to develop political support for value pricing in the Minneapolis-St. Paul region. This report summarizes the major activities that took place as part of this project, and includes as appendices the major documents that were produced.

Conclusions:
The research team evaluated four operating value pricing projects and a number of significant developing or attempted projects in other cities. This research focused on "lessons learned" to help shape the technical review and public outreach work of the Minnesota project. The research team worked with an Advisory Task Force to discuss the role of pricing and market-based solutions to recommend a value pricing pilot project and to assist in creating a constituency of support for pricing and the selected project. A list of 12 possible projects was reviewed and three projects were studied in detail. The Crosstown project was initially selected as the Advisory Task Force's first choice for a pilot project and a project proposal was prepared. After discussion of legislative issues, the project focus was shifted to a study of the I-394 HOT lane conversion project. Regional traffic modeling was completed to analyze the impacts on regional traffic patterns of a region-wide peak period freeway tolling system. A per-mile charge with higher charges during peak periods was evaluated. The research found that about 80 percent of trips remained on the freeways with about 15 percent changing route or destination and about 5 percent changing time of day or mode. Overall, this had the effect of reducing the number of freeway miles with level of service "F" by 59 percent. Equity and environmental justice were intended to be important factors in the development of project alternatives and the weighing of alternatives. However, these considerations proved difficult to evaluate quantitatively. These issues were discussed by the Advisory Task Force and it was recommended that these issues be addressed by dedicating revenues to either increased transit or subsidizing pricing participation for low income drivers.

Implementation:
The concept of value pricing has gained legislative and general public support as a result of research and outreach efforts over the past decade. This project, in particular, focused on outreach that would create a constituency of support for pricing. The work done on this project led directly to the support of the HOT legislation allowing the conversion of the I–394 HOV lanes to HOT lanes. The I-394 HOT lane project is currently being implemented. This research has formed the basis for the outreach activities that are being done as a part of the implementation of the I-394 HOT lane. On a national basis, the implementation and management of the national website clearinghouse for value pricing has a long-range benefit in the dissemination of information on value pricing and the building of general support for pricing.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200331.pdf

Report #2003-32

Principal Investigator:
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Technical Liaison:
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Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
74708 WO 191

Contract Period:
March 12, 2001 to July 31, 2003

Funding:
$68,000 Guidestar
$17,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Dynamic Estimation of Freeway Weaving Capacity for Traffic Management and Operations, Phase II

Description:
An adaptive procedure to estimate the time-variant capacity at consecutive weaving areas in real time is presented. The proposed procedure uses the volume/occupancy data commonly available from single loop detectors and estimates the maximum total volume that can enter a given freeway weaving segment through time. The procedure may be directly applicable in improving ramp metering operations, and in the development of better design of freeway weaving segments.

Conclusions:
In this research an adaptive procedure was developed to estimate the time-variant capacity of freeway weaving areas using commonly available data from single loop detectors. The proposed procedure explicitly addresses the effects of entrance ramp flows, which can be controlled through metering, on the maximum possible mainline volume approaching weave areas. First, the traffic behavior at several weaving sites that have consecutive weaving segments were analyzed using the loop and video data as well as visual observation. The major findings from this analysis include:

- The right-most-lane flow approaching a first weaving segment contains the vehicles exiting through the first and second exit ramps in a given consecutive weaving segment. This reduces the merging capacity at the mainline portion of the first weaving section and therefore results in a smaller weaving capacity than that of the second weaving segment. The level of capacity reduction depends on complex traffic patterns including the amount of vehicles exiting through the second off-ramp.
- The reduction of weaving capacity at the first weaving segment also results in increased congestion at the right-most-lane before the first weaving segment. The right-most-lane congestion can cause 'side friction' effects on the adjacent lanes, i.e., middle and leftmost lanes, whose speed levels decrease as a function of the right-most-lane speed level. It was also found out that there existed a clear pattern between the volume/ occupancy values of right-most and adjacent lanes.
- Most lane-changing within a consecutive weaving segment is discretionary and no clear pattern was found between amount of lane-changing and the capacity reduction of the merged lane.
- As in a single weave section, the maximum volume that can be accommodated by a consecutive weaving area varies through time, depending on the patterns of traffic flows as well as geometric conditions.

Implementation:
The procedure developed through this research may be directly applicable in improving ramp metering operations and in the development of better design of freeway weaving segments and locations. The use of time variant lane capacities instead of fixed lane capacities during freeway modeling will improve the effectiveness of ramp metering.
Consideration of the research results should be taken during any future Highway Capacity Manual update to improve the freeway design sections.
No measures or plans for measurement are proposed at this time.

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/200332.pdf

Report #2003-33

Principal Investigator:
Cathy French, University of Minnesota

CoPrincipal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
David Dahlberg, Mn/DOT, Office of Bridge

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 152

Contract Period:
December 20, 1999 to February 28, 2003

Funding:
$10,000 COPTRS
$140,000 STIP

Program:
Mn/DOT Transportation Research Program

Effects of Vertical Pre-Release Cracks on Prestressed Concrete Bridge Girders

Description:
Vertical cracks near the midspan of large-sized prestressed concrete bridge girders may develop during the curing process and can extend through the depth of the girder. The cracking is attributed to restrained shrinkage and thermal effects prior to release of the prestressing strands. Eighteen full-scale Mn/DOT Type 28M prestressed concrete beams were tested to investigate the effects of the cracks on the performance of the beams.

Conclusions:
As indicated by the finite element and experimental study results, the existence of prerelease cracks causes a reduction in the flexural crack initiation load of beams irrespective of the crack depth. On the other hand, there are several factors, such as the as-built concrete strengths being higher than the design specified values and conservative distribution factors, which tend to increase the flexural crack initiation load above the design value. As explained earlier, irrespective of whether the girder has pre-release cracks or not, some or all of this reserve capacity is being used by the girders so that the girders remain uncracked during their service life despite a possible reduction in the flexural crack initiation load from the design value. As a result, when making decisions about accepting or rejecting a girder that developed pre-release cracks, this reserve flexural cracking capacity due to higher concrete strength and conservative distribution factors should not be considered.

Implementation:
The procedures in place prior to the research, i.e., inspectors calling in to Central Office when cracks are observed, have not changed. However, discussions and decisions will benefit from the engineer's increased knowledge of the impacts of the vertical pre-release cracks on the girder. Through many publications and presentations, the research has added to the "bank of knowledge" for researchers and practitioners alike.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200333.pdf

Related Projects:
“Effects of Pre-Release Cracks on Prestressed Bridge Girder Performance Including Remaining Fatigue Life” 74708 WO 85

Report #2003-34

Principal Investigator:
Nikolaos ,Papanikolopoulos, University of Minnesota

Technical Liaison:
Nick Thompson, Mn/DOT, Metropolitan District

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 7

Contract Period:
September 1, 2001 to November 30, 2003

Funding:
$60,000 Guidestar
$15,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Sensor-Based Ramp Monitoring

Description:
A vehicle monitoring system able to record motion statistics is presented, with several experimental results from ramps in the Twin Cities. This system uses optical flow information to create virtual features based on trends in the optical flow, clustered to form vehicle objects.

Conclusions:
This phase has encompassed the creation of an algorithm for creating features based on the optical flow and the tracking of those features into vehicle objects. Several key successes were made. First, the model for tracking based on optical flow presents a useful source of information for image processing algorithms. Second, the system can track vehicles entering and leaving highway on ramps. However, due to the nature of the solution, the application does not track the vehicle when it stops in a ramp queue. The feature tracking algorithm requires high certainty in the optical flow in order to track features. This certainty appears to fail in situations where vehicles slow dramatically and occlude each other. Also, occlusions between vehicles cause the virtual features to “detach” themselves from the correct vehicle and follow some other vehicle. This occurrence then causes the vehicle statistics to be skewed and will ultimately result in the loss of tracking.

Implementation:
The "blob" technology used for monitoring human and vehicle activities has been included in a National Science Foundation proposal for an east coast homeland security application.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200334.pdf

Report #2003-35

Principal Investigator:
Jim McGraw, Mn/DOT, Office of Materials

CoPrincipal Investigator:
N/A

Technical Liaison:
N/A/

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
MnROAD

Program:
MnROAD

Selection of An Alternative Asphalt Extraction Solvent

Description:
The asphalt extraction solvent n-Propyl Bromide (nPB) is recommended as an alternative to the more hazardous d-Limonene and Trichloroethylene (TCE). A change to nPB and the implementation of on-site recycling with solvent recovery systems are recommended for all Mn/DOT district laboratories.

Conclusions:
1. Based on a literature search, communication with asphalt technology experts and results from our lab investigation, the n-propyl bromide (nPB) product was selected as an alternative solvent for d-limonene
2. With proper handling techniques and training nPB can be substituted for TCE and d- Limonene extraction solvent
3. Asphalt Extractions with nPB use less solvent per extraction, take less time, have shorter drying times
4. nPB Solvent Recovery Unit Payback time ranges from 3 months to 20 years depending on the quantities of extraction waste generated per year
5. Even with poor solvent handling technique in two of the labs, the exposure levels for the labs were far below EPA recommended value of 25 ppm calculated 8 hour Time Weighed Average (TWA).
6. Using nPB for asphalt extraction and by recycling nPB, the only waste generated would be a non- hazardous still bottom.
7. Using nPB for asphalt extractions would decrease Mn/DOT Laboratories hazardous waste, eliminate time-consuming reporting requirements and reduce annual solvent costs.

It is recommended that all Mn/DOT District Labs change from TCE or d-limonene extraction solvents to nPB and conduct on-site recycling with the purchase of solvent recovery systems. It is also recommended that Mn/DOT Industrial Hygienist give lab personnel training on the proper handling techniques when using nPB.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200335.pdf

Report #2003-36
This is Chapter 4 of Report # 200217REV

Principal Investigator:
Gene Skok, University of Minnesota

Technical Liaison:
Lou Tasa, Mn/DOT, State Aid District. 2

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
81655 WO 9

Contract Period:
September 1, 2001 to November 30, 2003

Funding:
$105,625
LRRB

Program:
CY2001 LRRB
INV 772

INV 772: Special Practices for Design and Construction of Subgrades in Poor, Wet, and/or Saturated Soil Conditions

Description:
Subgrade soils must be improved for highway embankment construction in cases of poor soil conditions. Enhancement selection and construction methods to be used for subgrade soil enhancement were developed from highway agency interviews, a questionnaire, and a literature review.

Conclusions:
Procedures to use for special subgrade conditions in Minnesota have been presented in this report. Most projects can be designed with the grade at least 5 ft (1.7 m) above the water table with adequate drainage provided to result in a good uniform well compacted subgrade. However, if the grade must be built closer to the water table and if peat or other undesirable materials exist in the grade then special procedures such as those presented here can be used.

Implementation:
There are no current plans to formally evaluate the results of implementing the subject research. However, there are mechanisms inplace to do so. Web activity can be monitored, as well as any feedback from users and LTAP training course evaluations can be analyzed. Implementation could also be gauged by the point at which the recommended procedures are incorporated into standard practice, i.e., manuals and policy. Additionally, this type of implementation requires ongoing updates as new findings from research become available and determine changes.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200336.pdf

This is chapter 4 of Report #2002-17REV
http://www.lrrb.gen.mn.us/pdf/2002.pdf

Related Projects:
LRRB INV 747 "Best Practices for Design and Construction of Low Volume Roads" 74708 WO 123

LRRB INV 754 "Traffic Supplement to Low Volume Roads Best Practices Manual" 74708 WO 180

RIC Task 7 - "Low Volume Road HMA Design Tool" 2003-015I

Report #2003-37

Principal Investigator:
David Levinson, University of Minnesota

Technical Liaison:
Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 8

Contract Period:
September 1, 2001 to November 30, 2003

Funding:
$84,546 COPTRS

Program:
FY2002 Mn/DOT Transportation Research

If They Come, Will You Build It?

Description:
Based on data from the past two decades, this research presents scientifically based models designed to assist with Twin Cities highway expansion planning. These models will be helpful to planners interested in shifting the emphasis from accommodating immediate demands to developing effective strategies for future growth.

Conclusions:
Since they serve as the major local commuting routes, the further growth of divided highways are more likely to be close to employment zones. Also divided highway growth follows the agglomeration tendency, that is, the neighboring areas of the existing corridors have a higher likelihood of new route development. As to population density, we find moderately dense areas have higher route growth probability than both the densely populated areas and the sparsely populated areas. Generally commercial zones and their neighborhood are positively and significantly related to divided highway growth probability, but they are not as significant as employment zones. Water areas have low divided highway growth probability. But agricultural areas sometimes are related to high growth probability, and we speculate that it may be because diverting from the highly urbanized areas save construction costs or divided highways connect urban and suburban areas and is used to spur economic development of the undeveloped areas. For secondary highways, since they are the proximate and ultimate connecting highways of urban settlements, the growth of secondary highways is strongly related to the settlement areas, and we find cells with a higher percentage of urban settlement area are more likely to have secondary highway growth. Besides employment zones and their neighborhood have a high likelihood of secondary highway growth. As to population density, both moderately populated areas and densely populated areas have a high secondary highway growth probability. Water areas and their neighborhood always have low secondary highway growth probability. The agricultural areas, however, are associated with a high likelihood of secondary highway growth, which may be due to agricultural areas' high reliance on secondary highways for product transport and commuting service.

Implementation:
The model developed as a part of this research has the potential to become a tool that can be used to produce better performing transportation networks over the long term by adapting decision rules to optimize performance-based investments. This would help with planning at Mn/DOT, the Metropolitan Council and in the "collar" counties. It would also help people to better understand the consequences, intended or unintended, of existing and/or proposed investment strategies.

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/200337.pdf

Report #2003-38

Principal Investigator:
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CoPrincipal Investigator:
Shashi Shekhar, University of Minnesota

Technical Liaison:
Ken Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 126

Contract Period:
August 22, 2000 to June 30, 2003

Funding:
$66,999.80 Pooled Fund
$210,000.20 Pooled Fund - MnROAD

Program:
2002 SP&R SPR-3(071)

A New Approach to Assessing Road User Charges: Evaluation of Core Technologies

Description:
A new system of road user charges is proposed, as new vehicle propulsion technologies may jeopardize financing transportation projects through motor fuel taxes. A system based on vehicle miles of travel (VMT) is proposed that would credit states or sub-state jurisdictions for the miles traveled within their boundaries. GPS and digital maps that may be used in such a system are evaluated to develop requirements for those components.

Conclusions:
Overall our analysis shows that the existing digital road maps are not adequate for road user charge system. They are not designed for application of road user charge system and may lead to inaccurate and unfair charges. It is clear that a new generation of digital maps is needed which can provide us with more accurate digital road map.

In the next generation of digital road map, we need to decide the desired digital road map accuracy, considering the road width.

Implementation:
As long as fuel consumption is expected to decrease due to more fuel-efficient and/or less fuel-dependent vehicles, transportation agencies will need to consider alternative approaches to funding transportation costs. Any proposals for change will need to be supported by solid research, operational field tests and support from high-level policy experts.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200338.pdf

Related Projects:
"A New Approach to Assessing Road User Charges (Tasks 1-4, 6) SP&R-3(071)" 79075 WO 1

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Report #2002-01

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
John Bieniek, Mn/DOT, Metro District Office of Traffic and Maintenance Operations

Administrative Liaison:
Bill Bunde, Mn/DOT

Contract:
74708 WO 125

Contract Period:
September 10, 1999 to September 30, 2001

Funding:
$40,000
STIP

Program:
Mn/DOT Transportation Research Program

Building Our Way Out of Congestion? Highway Capacity for Twin Cities

Description:
What would it take to build our way out of congestion in the Twin Cities? As part of this research project, researchers identified a method to answer that question and found a minimal set of highway capacity expansions that would accommodate future travel demand and guarantee mobility.

Conclusions:
The numerical solution to this problem isn't expected to quell debate about the relative merits of highway capacity expansions, but provide additional evidence to guide debate towards realistic expectations regarding the provision of highway capacity. The techniques developed here can also be applied to similar large problems, and so used to investigate and compare more realistic solutions to the increased travel demands.

In summary, the contributions of new knowledge that this research project makes are:
1. Selection and demonstrated successful implementation of a procedure to solve to large-scale NDP--largest known.
2. Numerical answer to what it would take to build our way out of congestion, thereby adding to this debate.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200201.pdf

Report #2002-02

Principal Investigator:
Ferrol Robinson,
SRF Consulting Group, Incorporated

CoPrincipal Investigator:
Michael Marti,
SRF Consulting Group, Incorporated

Technical Liaison:
Tom Eggum,
Saint Paul Director of Public Works

Administrative Liaison:
Jim Aamot,
Mn/DOT

Contract:
74330 WO 3

Contract Period:
June 25, 1998
to November 30, 2001

Funding:
$55,000
LRRB
$25,000
STIP

Program:
CY1996 LRRB
INV 721

Investigating the Effectiveness of Traffic Calming Strategies On Driver Behavior, Traffic Flow and Speed *(Phase II)*

Description:
The report details the impact of different types of traffic calming strategies on driver behavior, traffic flow, and speed. According to results, traffic calming can have a limited impact on average driver speed, with the greatest impacts in reducing the number and speed of those who travel at speeds greater than the 85th percentile speed.

Conclusions:
Researchers used a number of different approaches, including a literature search to determine results at a national level and local before-and-after studies in areas that implemented new traffic calming strategies. Researchers also compared an actual street before and after implementation of traffic calming devices to a driver simulation study of a street with and without traffic calming devices.

Research results indicate that traffic calming can have a limited impact on average driver speed. The greatest impacts on speed often occur in reducing the number and speed of outliers, or those who travel at speeds greater than the 85th percentile speed. The report details the impact of different types of traffic calming strategies on traffic speed and volume

Implementation:
Impacts of the dissemination of this information are further developments and progression in the area of traffic calming research and best practices development.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200202.pdf

Related Projects:
INV 721(Phase I) "Implications of New & Emerging Urban Design/ Traffic Calming Proposals on Tradition Traffic Safety & Geometry Design Standards" 74330 WO 1 Report #1998-04

INV 727 "Investigating the Effects of Traffic Calming Strategies on Driver Behavior" 74708 WO 86 Report #2002-20

INV 789 "Traffic Calming - Implementation Procedures and Tools" 86035 Report NONE13

Report #2002-03

Principal Investigator:
Mark Nelson and Daryl Taavola. URS Corporation

CoPrincipal Investigator:
N/A

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
N/A

Regional Operations and Maintenance of Traffic Systems Phase I: Feasibility Study

Description:
This report summarizes the results of several initiatives regarding the ongoing support of arterial management systems within the region, including a stakeholder survey, case studies that assess the experience of other regions, and a regional stakeholder forum, held August 14, 2001. It also contains findings and recommendations.

Conclusions:
1. Develop regional standards . Independent of the decision to go forward with a regional operations and maintenance program, agencies within the region should develop regional standards and processes for equipment, materials, specifications, installation, operations, maintenance and communications.
2. Go forward with Phase II of this regional operations and maintenance study. The results of the stakeholder survey and forum confirm that there is a strong interest and potential support for a regional operations and maintenance program.
3. Begin a dialog with Met Council's Transportation Advisory Board regarding the eligibility and priority of regional arterial management system projects for surface transportation program and congestion mitigation and air quality improvement program funding. Although a regional approach to operations and maintenance would serve the objectives of the Met Council, the eligibility and priority criteria set forth in the Met Council's 2001 Solicitation may not allow for the funding of projects with a regional scope. Existing criteria, particularly prioritizing criteria, focus on the characteristics of the specific segments of principal arterials and "A" minor arterials.
4. Initiate a regional operations and maintenance program (Phase III). Upon successful completion of Phase II and assuming that there is sufficient support from local agencies either directly or via the Met Council, go forward with the development of a regional operations and maintenance program.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200203.pdf

Report #2002-04

Principal Investigator:
Tom Burnham, Mn/DOT, Office of Materials

CoPrincipal Investigator:
N/A

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
MnROAD

Program:
MnROAD

Construction Report For MnROAD PCC Test Cells 32, 52 and 53

Description:
This report describes the results for physical characteristics of new jointed plain concrete test cells that replaced an existing aggregate-surfaced test cell and a nearby bituminous-surfaced transition area at MnROAD, a long-term pavement testing facility. It also summarizes the results of various material tests performed during and immediately following the construction of the test cells.

Conclusions:
The report describes the results for physical characteristics of new PCC test cells 32, 52, and 53. The report also summarizes the results of various material tests performed during and immediately following the construction of the test cells. Appendix C of the report provides information on the instructional installation procedures used during construction.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200204.pdf

Report #2002-05

Principal Investigator:
Michael Wade, University of Minnesota

Technical Liaison:
Bev Farraher, Mn/DOT, Metro District

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 71

Contract Period:
April 27, 1998 to March 31, 2001

Funding:
$24,780.80 Guidestar
$6,195.20 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Investigating The Effect On Driver Performance Of Advanced Warning Flashers At Signalized Intersections

Description:
This report summarizes the findings of a human factors analysis to determine the effects of advanced warning flashers (AWFs) on simulated driving performance. Researchers concluded that AWFs assist drivers with decision-making behavior and promote safer driving behavior.

Conclusions:
Results of this study point to two broad conclusions. First, AWFs appear to assist some drivers with decision-making behavior in the decision zone, and thereby promote safer driving behavior by these drivers. Second, field research is needed to ascertain if the findings apply to actual driving environments, particularly as regards to individual differences in how drivers interact with AWFs.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200205.pdf

Report #2002-06

Principal Investigator:
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Technical Liaison:
Paochen Mma, Mn/DOT, Office of Bridges

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 177

Contract Period:
August 2, 2000 to December 31, 2001

Funding:
$40,000
STIP

Program:
Mn/DOT Transportation Research Program

Analysis Tools and Rapid Screening Data for Distortional Fatigue in Steel Bridge Girders—Phase II

Description:
Differential deflection and web gap dimension trends apply to a varied spectrum of bridge configurations. The research resulted in a method to assess bridge girder differential deflection and distortional stress in actual steel bridges without complex analysis and modeling. Proposed procedures for evaluating out-of-plane stress should prove practical and aid in screening, identifying, and assessing bridges vulnerable to distortion-induced fatigue cracking.

Conclusions:
Trends concerning differential deflection and web gap dimensions should be applicable to a varied spectrum of bridge configurations. Analysis of results generated simple formulas for estimating differential vertical deflection and characterizing web-gap geometry. These formulas and the web-gap stress formula developed in the previous study renders a method by which bridge girder differential deflection and distortional stress may be assessed in steel bridges without the need for complex modeling and analysis. Proposed procedures for evaluating out-of-plane stress should prove practical and aid in screening, identifying, and assessing bridges vulnerable to distortion-induced fatigue cracking.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200206.pdf

Related Projects:
"Monitoring and Assessment Program for (Mn/DOT Bridge No. 79000) at Wabasha over the Mississippi River Phase I." 74708 WO 18 Report #1998-22

"Remote Monitoring of Distortional Fatigue in Multi-Girder Steel Bridges" 74708 WO 94 Report #2000-16

"Phase 3 - Rapid Assessment of and Decision-Making Strategies for Distortional Fatigue in Mult-Girder Steel Bridges" 81655 WO 14 Report #2004-48

"Rapid Assessment and Decision Making Strategies for Distortional Fatigue Multi-Girder Steel Bridges - Phase 4" 81655 WO 120 Report #2005-38

Report #2002-08

Principal Investigator:
Jerome Hajjar, University of Minnesota

Technical Liaison:
Steve Ellis, Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 24

Contract Period:
February 17, 1997 to September 30, 2001

Funding:
$34,540
STIP

Program:
Mn/DOT Transportation Research Program

Live Load Stresses In Steel Curved Girder Bridges

Description:
This report summarizes research to investigate the behavior of the curved girder bridge system through all phases of construction, as well as to a series of live load field tests. In addition, researchers investigated the effects of change in temperature on the bridge behavior and tracked any changes in behavior of the bridge system over time and under service load conditions.

Conclusions:
Two live load tests were preformed on the bridge as part of this research, one in 1997 and one in 2000, included loading with up to nine 50 kip trucks. The field tests provided good insight into the general behavior of this bridge system, both under isolated loading conditions and over the three years separating the two tests. With respect to total stress, correlation for the gages was generally strong in the midspan region of the bridge for both sets of live load tests, moderate to strong in the gages located near the middle pier of the bridge, and weak to moderate in the crossframes. When the correlations were moderate in the midspan and middle pier gage lines, it was usually due to very low stress magnitudes, resulting in the potential for higher percent errors between measured and computed data. In addition, stresses were usually overpredicted in the midspan and middle pier regions, but sometimes remained underpredicted in the crossframes.

Implementation:
Mn/DOT's Implementation Funding Program funded a project titled "DESCUS Training for Live Load Stresses in Steel Curved Girder Bridges" IMP 2003-06

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200208.pdf

Related Projects:
"Stresses in Steel Curved Girder Bridges" 72443
WO 155 Report #96-28

"DESCUS Training for Live Load Stresses in Steel Curved Girder Bridges" 84649, IMP 2003-06

Report #2002-09

Principal Investigator:
Eil Kwon, University of Minnesota

Technical Liaison:
John Bieniek, Mn/DOT, Metro District Office of Traffic and Maintenance Operations

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 107

Contract Period:
March 22, 1999 to November 30, 2001

Funding:
$76,800 Guidestar
$69,200 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Capacity Analysis for Dynamic Bottlenecks and Alternative Concepts for Coordinated Ramp Metering Operations

Description:
This project involved the detailed review of coordinated metering algorithms currently operating in the United States and a simulation analysis to examine the performance of three algorithms that represent each coordination approach. Based on the analysis results, researchers developed alternative metering approaches by combining conventional zone-wide control with fuzzy coordination.

Conclusions:
This research conducted performance analysis of three algorithms representing each coordination approach, i.e., the Denver incremental coordination, the Seattle Fuzzy metering and the Minnesota explicit section-wide coordination approaches, using a macroscopic simulation model under the same geometry and traffic demand conditions. The simulation results from the incremental and fuzzy metering algorithms indicated potential negative impacts of ramp-queue override policies on the management of mainline congestion. In case of the incremental algorithm, the case without queue control produced better performance than the case with queue control, i.e., more mainline vehicle-miles with less congested vehicle-hours, while the Fuzzy metering without employing queue rules showed compatible vehicle-miles with less congestion than the other cases with queue weights. Further, the Minnesota algorithm, which does not employ queue override policies, consistently produced more evenly distributed traffic flows on mainline with lower level of congestion than other algorithms. However, the comparison of the average ramp vehicle-hours indicated that the Minnesota algorithm resulted in more number of ramps with high vehicle-hour values than other algorithms.

Implementation:
The opinion of the technical liaison is that the exposure of this information has caused a new direction of thinking, which has already happened, and will continue to influence actions for the next few years.

This project aids in meeting one of Mn/DOT's basic transportation strategies; Bottleneck Removal. "Remove bottlenecks to improve mobility and safety in the state's urban highway system through completion of a continuous three lane beltway around the Twin Cities and reconstruction of congested major interstate interchanges". Secondly, this project aids in what Citizens Want; "To have all transportation systems and services work smoothly together." Finally, this project aids in Mn/DOT's Vision "A coordinated transportation network that provides safe, user-friendly access and movement, and responds to the values of Minnesota's citizens."

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/200209.pdf

Report #2002-10

Principal Investigator:
George Rapp, University of Minnesota—Duluth

CoPrincipal Investigator:
Susan Mulholland, Duluth Archaeology Center

Technical Liaison:
Craig Johnson, Mn/DOT, Office of Technical Support

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 148

Contract Period:
February 8, 2000 to December 31, 2001

Funding:
$81,646
STIP

Program:
Mn/DOT Transportation Research Program

Site/Environmental Correlations in Northeastern Minnesota

Description:
This project was designed to enhance the Mn/Model databases to better represent the landscapes of northeastern Minnesota with respect to older Paleoindian/Archaic sites.

Conclusions:
The lack of positive results precludes any evaluation of the predictive value of the environmental variables tested. Although the logistic regression model was tested on a portion of the known sites, the field survey design had neither enough random points for a rigorous test nor enough high probability locations for even an initial test. Without any positive results, it is impossible to say whether the variables are useful in predicting new site locations. Without a spatial application of the model, it is also impossible to compare the results to that of Mn/Model.

Several possible interpretations can be explored. One is that these variables have no predictive value; the negative results of survey derive from use of invalid environmental variables. In other words, the concept of using known site location to predict other sites is not valid, either for early sites or for northeastern Minnesota or perhaps both. Since the concept has been widely used, this is unlikely. Another interpretation is that the test was invalidated from any of several problems in the methodology; perhaps combinations of several factors could interact to exacerbate the results.

A third interpretation is that the low density of random points (constraints by Mn/DOT) or the low number of points surveyed (constraints by budget) reduced the chance of locating sites beyond a reasonable likelihood. If the original testing program as initially conceived had been conducted, there would have been a greater chance that at least some sites would have been found. New sites, although not proving the model, would have at least indicated whether the model as constructed was worth further testing. A more extensive testing program incorporating random sampling with a much larger sample and distribution over the entire range of probability values could then have been planned.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200210.pdf

Report #2002-11

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Richard West, Otter Tail County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
74708 WO 190

Contract Period:
February 5, 2001 to July 31, 2001

Funding:
$15,000 LRRB

Program:
CY2000 LRRB INV 763

The Effects of In-Lane Rumble Strips on the Stopping Behavior of Attentive Drivers

Description:
This project involved investigating the effect, if any, of rumble strips on stopping behavior at simulated rural-controlled intersections. Results indicate that none of these manipulations seem to affect the point at which drivers stop at the controlled intersections or the point at which drivers start to slow down at controlled intersections. The research did reveal drivers brake more, earlier, further away from the intersection when rumble strips are installed than they do if there are no rumble strips.

Conclusions:
The intent of this study was to investigate the effect, if any, of rumble strips on stopping behavior at simulated rural controlled intersections. We investigated rumble strip design and deployment issues. With respect to design, we varied the rumble strip type (full width or wheel track) and with respect to deployment we varied the number of rumble strips (zero, two, or three). To test the varied aspects of design and deployment the rumble strips were tested on two different types of controlled intersections (two-way or four-way) and in the presence or absence of traffic. Results indicate that none of these manipulations seem to affect the point at which drivers stop at the controlled intersections or the point at which drivers start to slow down at controlled intersections.

The lone effect of rumble strips was observed in braking pattern. In this simulation experiment we found that drivers brake more, earlier, when they are further away from the intersection, when rumble strips are installed than they do if there are no rumble strips. Although they started to slow down at the same time and finished their braking at the same time, there was more use of the brake earlier in the slowing down maneuver in the presence of rumble strips. Results also reveal that drivers brake more, earlier when full coverage rumble strips are in place than they do when wheel track rumble strips are installed. This result seems to indicate that rumble strips are likely to cause drivers to use their brakes more, earlier and in turn perhaps entails safer, more controlled, braking behavior at rural controlled intersections. However, there may be a downside: more early braking could be associated with increased rates of rear end collisions from cars that are following and not expecting to brake so soon. Before further implementation of rumble strips it would be worth investigating whether the possible safety benefit of earlier braking at rural intersections (outfitted with rumble strips) outweighs the possible higher incidence of rear end crashes.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200211.pdf

Related Project:
"Investigating the Effects of In-Lane Rumble Strips on the Stopping Performance. of Sleep-Deprived & Alcohol-Impaired" 81655 WO 48, INV 781

Report #2002-12

Principal Investigator:
Jerry Fruin, University of Minnesota

Technical Liaison:
Robert Gale, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Ron Cassellius, Mn/DOT

Contract:
74708 WO 155

Contract Period:
February 15, 2000 to August 31, 2001

Funding:
$50,292
STIP

Program:
Mn/DOT Transportation Research Program

Where Does Minnesota's Grain Crop Go?

Description:
This study describes the movement of grain shipments from Minnesota to their final destinations. Minneapolis and Mississippi River ports were the most important destinations, receiving 28.4 percent of all shipments. Rail was used for 494 million bushels (14.1 million tons) or 64 percent of all grains. Both destination and modal percentages varied substantially by grain and by crop report district.

Conclusions:
There are no significant and/or unexplained inconsistencies from the estimates derived from the sample of reporting elevators when compared with data from public data sources.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200212.pdf

Related Projects:
"Filling the Livestock Feed Troughs of Minnesota and Beyond" 74708 WO 155, Report #2002-13

"AG - Executive Summary" 74708 WO 155, Report #2002-14

Report #2002-13

Principal Investigator:
Jerry Fruin, University of Minnesota

Technical Liaison:
Robert Gale, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Ron Cassellius, Mn/DOT

Contract:
74708 WO 155

Contract Period:
February 15, 2000 to August 31, 2001

Funding:
$50,292
STIP

Program:
Mn/DOT Transportation Research Program

Filling the Livestock Feed Troughs of Minnesota and Beyond

Description:
In this project, researchers identified 1999 grain and oilseed production levels, livestock populations in individual counties of the state, and required amounts of feed for the livestock populations. From this analysis, they determined net feed grain surpluses and deficits. They calculated the net movement of all grain after local feeding and processing activities to track the impacts on Minnesota roads.

Conclusions:
Efforts to quantify and understand the dynamics of livestock consumption of Minnesota produced grains require tenancity, rigor, and the assistance of knowledge animal scientists. The intricacies of retaining adequate numbers of young stock to maintain breeding herds and flocks were challenges necessitated by the lack of data about certain animal categories. In this paper a methodology utilizing linked spreadsheets in a n Excel workbook was adopted in order to produce verifiable results and managing assumptions. Numerous tables, graphs, and maps were generated in order to express volumes of crops in bushels, tons, and dollars of market value. What has been learned about the importance of livestock consumption of local cross in 1999? With respect to corn, this study identifies the consumption of 37% of the corn crop by livestock. In addition, 34% of the soybean crop is crushed to satisfy the dietary requirements of livestock residing in the state. There are also areas of the state with excellent production of grains and oilseeds that have minor livestock populations to utilize feed grains. In some cases there is utilization of distillers dried grains and solubles (DDGS) by turkeys, swine, dairy, and beef cattle. However, we have learned from trade sources that the majority of the DDGS produced by Minnesota ethanol plants is dried and shipped out of the state to be fed to livestock in other states.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200213.pdf

Related Reports:
"Where Does Minnesota's Grain Crop Go?"74708 WO 155, Report #2002-12

"AG - Executive Summary" 74708 WO 155, Report #2002-14

Report #2002-14

Principal Investigator:
Jerry Fruin, University of Minnesota

Technical Liaison:
Robert Gale, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Ron Cassellius, Mn/DOT

Contract:
74708 WO 155

Contract Period:
February 15, 2000 to August 31, 2001

Funding:
$50,292
STIP

Program:
Mn/DOT Transportation Research Program

AG - Executive Summary

Description:
This report summarizes the two studies in the Minnesota Agricultural Transportation Database project. The first study analyzed Minnesota elevators' monthly grain shipments from July 1999 through June 2000 (2002-12). The second study determined 1999 levels of grain and oilseed production and enumerated livestock populations in individual counties.

Conclusions:
Typically, Minnesota farmers produce about 36 million tons of grains and oilseeds. About 2/3 of that production (25 million tons) must be transported significant distances; half is shipped to national and international markets. This study found that

· All transportation modes remain important: trucks dominate movement from elevators to processors and to Mississippi River ports and Duluth/Superior, trains of 50 and 100 cars dominate the long-distance movements to the Pacific Northwest, Mexico, and selected feed markets. However, 18% of Minnesota elevator shipments move by rail in 1-26 car lots.

· The Mississippi River remains the most important transportation artery for Minnesota's surplus grain.

· Livestock consumption of grain increased from 1985 to 1999, but not as much as the grain and soybeans production in the state.

· More agricultural movement is expected between Minnesota and Mexico and between Minnesota and Canada.

· Duluth/Superior has become an important outlet for soybeans due in part to the expansion of the soybean growing area into the Red River Valley and North Dakota.

· Expanded corn and soybean processing within Minnesota will reduce the quantities of unprocessed commodities being shipped out of the state. However, additional quantities of distiller's grains, ethanol, soybean

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
Call the Mn/DOT Library at 651/296-2385 for the report.

Related Projects:
"Where Does Minnesota's Grain Crop Go?" 74708 WO 155, Report #2002-12

"Filling the Livestock Feed Troughs of Minnesota and Beyond" 74708 WO 155, Report #2002-13

Report #2002-15

Principal Investigator:
Andrew Drescher, University of Minnesota

Technical Liaison:
Roger Olson, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 42

Contract Period:
July 24, 1997 to July 31, 2000

Funding:
$130,000 STIP

Program:
Mn/DOT Transportation Research Program

Investigation of Recycled Asphalt Pavement (RAP) Mixtures

Description:
This report presents the results of a study on recycled asphalt pavement (RAP) mixtures. The addition of RAP makes the mixture stiffer, as evidenced by an increase in resilient modulus and complex modulus measurements, according to the research. The report includes recommendations regarding the proper temperatures and loading frequencies for use in the complex modulus test. It also gives the percentage of RAP and the respective asphalt binder grade necessary to yield the stiffness similar to a virgin mixture.

Conclusions:
Based upon resilient modulus and complex modulus test results, the RAP contents and respective asphalt binders shown below will result in a stiffness similar to a virgin mixture:

Recommended RAP Contents and Asphalt Binders:

Original Asphalt Grade	Asphalt Grade with RAP	RAP Content with District 6 RAP	RAP Content with District 8 RAP
PG 58-28	PG 52-34	20%	10%
PG 58-28	PG 46-40	50%	35%
PG 52-34	PG 46-40	25%	15%

However, it is important to note that additional testing is recommended to verify these mixtures will have adequate performance in the field. The low temperature cracking potential of these mixtures should be evaluated prior to use.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200215.pdf

Report #2002-16

Principal Investigator:
Michael Wade, University of Minnesota

Technical Liaison:
Ernest Fiala, Redwood County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 172

Contract Period:
August 2, 2000 to January 31, 2002

Funding:
$41,750
LRRB

Program:
CY2000 LRRB
INV 761

Forward Looking Blindspots: A Report of A-Pillar Induced Field-of-View Obstruction and Driver Performance in a Simulated Rural Environment

Description:
This study analyzed the relationship between the size of the forward looking blindspot (FLB) produced by vehicles A-post (windshield frame), the speeds of two vehicles approaching an intersection at right angles, and driver behavior relative to a likely accident event. Target vehicle acquisition rate increased with the activity level of the scanning type. Not surprisingly, collision rates decreased with increases in scanning level.

Conclusions:
This study analyzed the relationship between the size of the forward looking blindspot (FLB) produced by vehicles A-post (windshield frame), the speeds of two vehicles approaching an intersection at right angles, and driver behavior relative to a likely accident event.

Researchers observed 28 volunteer participants directly and by four channels of on-board video cameras while they drove in a simulator at the Human Factors Research Laboratory. They noted the way that participants scanned the virtual environment and scored at four levels of scanning activity. They also tracked visual acquisition of the target vehicle and incidence of collision.

Only 6.3 percent of the total fell into type one scanning (eyes fixed). Type II (eyes only) accounted for the highest incident rate at almost 44 percent. The study considered both as "inactive" forms of scanning.

Target vehicle acquisition rate increased with the activity level of the scanning type. The target acquisition rate increased significantly from scanning level one to level two and from scanning level two to level three. There was not a significant increase in the acquisition rate from scanning level three to level four.

Not surprisingly, collision rates decreased with increases in scanning level. Collision rates significantly dropped between scanning levels two and three and scanning levels three and four. Yield signs at intersections produced no significant correlation with acquisition rate, collision rate, or scanning level.

Implementation:
By including the information in the Minnesota Department of Safety's Driver Manual, new drivers will be informed of the importance of moving their head around the A-pillars of a vehicle to see approaching traffic. The poster, news segment, and presentations about the importance of avoiding the A-pillar blindspot have and will continue to inform drivers. Knowing this information should decrease accidents and make rural uncontrolled intersections safer.

The final report includes a chapter with discussion on additional implications for engineering of vehicles and traffic control measures.

Implementation Outcome:
Change without measures

Report Located At: http://www.lrrb.gen.mn.us/pdf/200216.pdf

Report #
2002-17REV

Principal Investigator:
Gene Skok, University of Minnesota

Technical Liaison:
David Van Duesen, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 123

Contract Period:
6/28/1999 to 6/30/2002

Funding:
$5,000 COPTRS
$150,000 LRRB

Program:
CY1999 LRRB INV 747 and Mn/DOT Transportation Research Program

INV 747: Best Practices For the Design And Construction Of Low Volume Roads

Description:
This report presents information about the use of the mechanistic-empirical procedure (MnPAVE) in designing hot-mix asphalt pavements in Minnesota. It includes best practices on setting up projects most effectively to follow specifications.

Conclusions:
This report presents information about the use of the mechanistic-empirical procedure (MnPAVE) in designing hot-mix asphalt pavements in Minnesota. Researchers developed the MnPAVE software program using information from the Minnesota Road Research Project (MnROAD) test facility and from 40-year-old test sections around Minnesota. MnPAVE procedures use Equivalent Standard Axle Loads (ESALs) to evaluate traffic loading, and the report includes methods to estimate these values for design purposes over a 20-year design life, as well as a procedure to measure vehicle type distributions. In addition, the report presents an evaluation of subgrade soils for each thickness design procedure, summarizes Minnesota Department of Transportation (Mn/DOT) specifications that relate to embankment soil construction and to construction of the pavement section materials, and recommends specific density or quality compaction using a control strip. It also includes best practices on setting up projects most effectively to follow specifications.

Implementation:
In 2003, the Research Implementation Committee of the LRRB funded a project titled "Low Volume Road HMA Design Tool" (Task 7) to develop an HMA design tool accessible via the Internet using the results of the subject research as well as the Asphalt Paving Guide already available on the LRRB's web site. The task scoping document includes a plan to extend the functionality of the application with Server Side Web programming by including a feedback form for comments and questions.

The Minnesota LTAP program held a pilot class in June 2004 titled Best Pavement Design Practices for City Streets and County Roads using the materials developed under the research projects. The pilot class was taught by Gene Skok and Pat Murphy. In October 2004, two additional classes were taught by Ann Johnson.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200217REV.pdf

Related Projects:
LRRB INV 754 "Traffic Supplement to Low Volume Roads Best Practices Manual"
74708 WO 180 This project replaced Chapter 3 in Report #2002-17REV

LRRB INV 772 "Design and Construction of Pavement Embankments in Minnesota"
81655 WO 9 This project replaced Chapter 4 in Report #2002-17REV

RIC Task 7 - "Low Volume Road HMA Design Tool"

Report #2002-18

Principal Investigator:
Alireza Kamyab,
Iowa State University

CoPrincipal Investigator:
Gary Thomas,
Texas Transportation Institute

Technical Liaison:
David Heyer,
Mahnomen County

Administrative Liaison:
Clark Moe,
Mn/DOT

Contract:
74995 WO 2

Contract Period:
4/19/2000
to April 30, 2002

Funding:
$100,676
LRRB

Program:
CY2000
INV 756

Methods to Reduce Traffic Speed in High Pedestrian Areas

Description:
Researchers collected speed data at four study sites under existing conditions and at two sites, in Twin Lakes and Bemidji Lake, both under existing conditions and after the installation of proposed speed reduction strategies. The research study shows that the traffic calming strategy at Twin Lakes effectively reduced the main speed and improved speed limit compliance in both the short and long term. Despite proven effectiveness, the deployed speed reduction treatment in Bemidji Lake failed to lower the speed at the study site.

Conclusions:
The collected speed data indicate that less than 50 percent of vehicles complied with the posted speed limits at the selected study sites under the existing conditions. The 85th percentile speed, which sometimes referred to as the critical speed, is traditionally used as a guide in establishing reasonable speed limits. However, as the data shows, the observed 85th percentile speeds were generally higher than the posted speed limits in all four sites. Thus, either the current speed limits should be changed or some types of speed reduction techniques had to be implemented to ensure a safer environment for the pedestrians and drivers at the selected sites.

Implementation:
No measures have been taken to assess the impacts of the project. However, Mahnomen County continues to install its removable island each spring at Twin Lakes and, together with the in-place center and shoulder striping, has observed reduced traffic speeds.

Several additional comments should be noted that relate to future research: Two recommendations from the research panel were to 1) look at how the successful strategies used in Mahnomen could be implemented elsewhere, and 2) conduct a thorough cost/benefit analysis on traffic calming techniques. The subject research has been cited in the new LRRB research project (No. 2002-18R) that promises some progress in these areas.

It can be difficult to define keywords for proper literature and database searches. Relevant references were found in reports that did not include the keywords, "traffic calming" or "speed reduction". Literature searches should include at least a brief overview of traffic research by someone with in-depth knowledge of the topic to identify potential related research.

Implementation Outcome:
Change without measures

Report Located At: http://www.lrrb.gen.mn.us/pdf/200218.pdf

Report #2002-19

Principal Investigator:
Andrew Drescher, University of Minnesota

Technical Liaison:
Shongtao Dai, Mn/DOT, Office of Materials

Administrative Liaison:
Ron Cassellius, Mn/DOT

Contract:
74708 WO 40

Contract Period:
July 24, 1997 to December 31, 2002

Funding:
$100,000 LRRB

Program:
CY1998 LRRB INV 728

Superpave Level One Mix Design At The Local Government Level

Description:
This report presents the results of an investigation into the use of the Superpave asphalt mix design methodology at the local government level in Minnesota. In the project, researchers combined low-cost natural sand with locally available aggregates from four sources: limestone, quartzite, and partially crushed river gravel, and granite. They evaluated coarse and fine aggregate gradations, along with the use of two asphalt grades.

Conclusions:
Researchers combined low-cost natural sand with locally available aggregates from four sources: limestone, quartzite, and partially crushed river gravel, and granite. Course and fine aggregate gradations, along with the use of two asphalt grades were evaluated.

It was difficult to achieve the Superpave volumetric requirements of voids in mineral aggregate (VMA) and voids filled with asphalt (VFA) at 4 percent air voids, regardless of the gradation. A target air void content of 3 percent satisfied the VFA requirement, even though the VMA requirement could not be fulfilled. The fine aggregate gradations produced densities indicating that the mixtures might be tender during construction, but not necessarily be susceptible to rutting. The coarse-graded mixtures did not show the tenderness problem, but did show that they might be susceptible to rutting.

Resilient modulus testing showed little or no difference in the mixtures, regardless of aggregate source or gradation. The difference in resilient modulus due to asphalt grade was apparent only at the intermediate temperatures, and not at the highest or lowest test temperatures. Moisture sensitivity testing showed that all the mixtures studied had adequate durability. Indirect tensile creep and Asphalt Pavement Analyzer rut testing indicated that resistance to low temperature cracking and rutting may be improved by decreasing the lower performance grade binder grade and increasing the upper PG binder grade, respectively.

Implementation:
Mn/DOT's Implementation Funding Program funded a project titled "Guidelines for Superpave Level One Mix Design at the Local Government Level" IMP 2003-09 The project developed guidelines and a training package for using gyratory (Superpave) mixtures on low volume roads at the local government level.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200219.pdf

Related Project:
"Guidelines for Superpave Level One Mix Design at the Local Government Level" 85045, IMP 2003-09

Report #2002-20

Principal Investigator:
John Carmody, University of Minnesota

CoPrincipal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Mark Lober, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract:
74708 WO 86

Contract Period:
June 22, 1998 to March 31, 2002

Funding:
$50,000
LRRB

Program:
CY1998/CY1999
LRRB
INV 727

Investigating the Effects of Traffic Calming Strategies on Driver Behavior

Description:
The report details the results of two simulator experiments on traffic calming. Taken together, the two experiments show that the use of median islands, chokers, and planters are likely to produce measurable reductions in traffic speed. Further, the results obtained with the driving simulator parallel the direction of results obtained in the real world study of the urban environment of Franklin Avenue.

Conclusions:
Taken together, the two Experiments reported here show that, if median islands, chokers and plantings are deployed, they are likely to produce measurable reductions in traffic speed. Further research is required to discover how the specific placement or spacing of the traffic calming
elements would affect traffic speeds. Further, the results obtained with the driving simulator parallel the direction of results obtained in the real world study of the urban environment of Franklin Avenue. It should be noted that of the two experiments presented here, just one has a *before-and-after* real world parallel. While the results of the *before-and-after* simulator study parallel the results of the real world study, conducted by SRF Consulting Group, Inc., it would be useful to run additional simulator studies concurrently with real world studies. This would provide more information and would improve our understanding of the relationship between real world driving and simulator driving. Further, the issue of what denotes operationally important (or meaningful) speed reduction merits consideration. The results obtained in these studies indicate only modest reductions in speed after the installation of traffic calming elements. These speed reductions are statistically significant. However, it remains to be seen whether the real, but small, speed reductions are operationally important in the real world of roadway design or in terms of the public's perception. More research is needed to explore what "effective" means in traffic calming efforts. A systematic research program must be conducted before traffic calming standards are implemented.

Implementation:
Impacts of the dissemination of this information are further developments and progression in the area of traffic calming research and best practices development.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200220.pdf

This project relates to:
INV 721(Phase I) "Implications of New & Emerging Urban Design/Traffic Calming Proposals on Tradition Traffic Safety & Geometry Design Standards" 74330 WO 1 Report #1998-04

INV 721 (Phase II) "Investigating the Effectiveness of Traffic Calming Strategy. on Driver Behavior, Traffic Flow & Speed" 74330 WO 3 Report #2002-02

INV 789 "Traffic Calming - Implementation Procedures and Tools"
86035 Report NONE13

Report #2002-21

Principal Investigator:
Nikolaos Papanikolopoulos, University of Minnesota

Technical Liaison:
Farideh Amiri, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 158

Contract Period:
June 1, 2000
to February 28, 2002

Funding:
$62,000
LRRB

Program:
CY1999 LRRB
INV 750

Algorithms for Vehicle Classification: Phase II

Description:
This report summarizes the research behind a real-time system for vehicle detection and classification in images of traffic obtained by a stationary CCD camera. Implemented on a dual Pentium PC equipped with a Matrox Genesis C80 video processing board, the system performed detection and classification at a frame rate of 15 frames per second. Detection accuracy approached 95 percent, and classification of those detected vehicles neared 65 percent.

Conclusions:
The system models vehicles as rectangular bodies with appropriate dynamic behavior and processes images on three levels: raw image, blob, and vehicle. Correspondence is calculated between the processing levels as the vehicles move through the scene.

This report also presents a new calibration algorithm for the camera. Implemented on a dual Pentium PC equipped with a Matrox Genesis C809 video processing board, the system preformed detection and classification at a frame rate of 15 frames per second. Detection accuracy approached 95 percent, and classification of those detected vehicles neared 65 percent. The report includes an analysis of scenes from highway traffic to demonstrate this application.

Implementation:
The publication and presenting of this research at a national conference has added to the body of knowledge relative to video detection and classification of vehicles. There have been several Technical Liaisons during the seven-year life of the video processing technology program. There is no record of representation by the LRRB on the technical advisory panel for the Phase I or II research projects. The most recent Technical Liaison, Farideh Amiri, suggested that Jerry Kotzenmacher might have future interest, because he is presently responsible for a portable NIT research project. Discussions with Jerry indicated that they do not intend to add any devices or techniques to their Non-Intrusive Technologies project.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200221.pdf

Related Reports:
LRRB INV 732 "Algorithms for Vehicle Classification" 74708 WO 88
Report #2000-27

Report #2002-22

Principal Investigator:
Bruce Wilson,
University of Minnesota

CoPrincipal Investigator:
Anita Thompson,
University of Minnesota

Technical Liaison:
Richard Larson,
Mille Lacs County

Administrative Liaison:
Dan Warzala,
Mn/DOT

Contract:
74708 WO 168

Contract Period:
May 12, 2000
to February 28, 2002

Funding:
$34,000
LRRB

Program:
CY2000 LRRB
INV 759

The Impact of Roughness Elements on Reducing the Shear Stress Acting on Soil Particles

Description:
This report presents the results from a study on shear stress partitioning for vegetation. Particle shear accounted for 13 to 89 percent of the total shear. Shear partitioning theories developed for wind erosion adequately represent the observed data and can be used to determine an appropriate vegetation density for a threshold particle shear.

Conclusions:
The study used idealized shapes to represent vegetal elements. Researchers designed and constructed a unique laboratory hydraulic flume, which they used in conjunction with hot-film anemometry to measure particle shear. They also designed and constructed instrumentation to measure the form shear on individual rigid vegetal elements, taking detailed spatial and temporal shear stress measurements for three element densities. Form shear was measured on each element within the test array. The study investigated a total of 16 test scenarios. Particle shear accounted for 13 to 89 percent of the total shear. Shear partitioning theories developed for wind erosion adequately represent the observed data and can be used to determine an appropriate vegetation density for a threshold particle shear.

Implementation:
Since this project was basic research, the impacts cannot easily be attributed to specific actions or results. The main objective going into the project was to gain knowledge and that was accomplished. The new knowledge will be used by the researcher in teaching and in developing new research that can be applied. Mn/DOT Environmental Services personnel will use the knowledge indirectly as they conduct training. The Local Road Research Board will use what its learned about this research to steer additional research in the area of erosion control. Because the research has been documented and is catalogued in the transportation library system, anyone with an interest in or conducing research in the topic area will have access to the research results and be able to learn from it and build upon it.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200222.pdf

Report #2002-23

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
Kristie Billiar, Mn/DOT, Office of Transit

Administrative Liaison:
Sandy McCully, Mn/DOT

Contract:
74708 WO 93

Contract Period:
November 1, 1998 To December 31, 2001

Funding:
$50,000 LRRB

Program:
CY1998 LRRB INV 733

Development and Testing of a Vehicle/Pedestrian Collision Model for Neighborhood Traffic Control

Description:
This report presents an approach to assess the effect of vehicle traffic volumes and speeds on pedestrian safety. It shows that the probability of standardized pedestrian conflict resulting in a collision can be computed given data on the distribution of vehicle speeds and headways on a residential street.

Conclusions:
The study used idealized shapes to represent vegetal elements. Researchers designed and constructed a unique laboratory hydraulic flume, which they used in conjunction with hot-film anemometry to measure particle shear. They also designed and constructed instrumentation to measure the form shear on individual rigid vegetal elements, taking detailed spatial and temporal shear stress measurements for three element densities. Form shear was measured on each element within the test array. The study investigated a total of 16 test scenarios. Particle shear accounted for 13 to 89 percent of the total shear. Shear partitioning theories developed for wind erosion adequately represent the observed data and can be used to determine an appropriate vegetation density for a threshold particle shear.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200223.pdf

Report #2002-24

Principal Investigator:
Vladimir Cherkassky, University of Minnesota

Technical Liaison:
Steve Bahler, Mn/DOT

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 193

Contract Period:
January 22, 2001 to June 30, 2002

Funding:
$32,000 Guidestar
$8,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Wireless Transmission of Image and Video Data

Description:
This project focuses on the issues involved in wireless transmission of video data and addresses two main issues: video compression and quality of service. The report describes the research experiment, analysis, and results.

Conclusions:
Researchers compared several compression techniques that are commercially available and recommended wavelet-based compression technique for video compression and network prioritization for issues related to quality of service.

Implementation:
Mn/DOT did not implement the results of the study. The networks used for the systems have been adequate for their intended purpose. To implement the results, additional hardware is required, and the software must be configured.

Implementation Outcome:
Knowledge gained.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200224.pdf

Related Project:
"Quality of Service Implementation for Transmission of Video Data - Phase 2" 81655 WO 38 Report #2004-34

Report #2002-25

Principal Investigator:
Bojan Guzina, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 137

Contract Period:
September 24, 1999 to September 30, 2001

Funding:
$60,303
STIP

Program:
Mn/DOT Transportation Research Program

Delineation of the Stiff Layer from FWD Measurements

Description:
The development of a novel backcalculation technique for delineating the soil profile underlying asphalt pavements from falling weight deflectometer (FWD) measurements results from this research project.

Conclusions:
The FWD is a widely used non-destructive test device for estimating the pavement stiffness properties. However, the conventional elastostatic interpretation of FWD measurements is generally associated with a number of inconsistencies. The purpose of this project is to develop a reliable and effective dynamic backcalculation method capable of estimating the location and properties of the permanent or seasonal stiff layer (as well as other pavement stiffness properties) from FWD measurements. The backcalculation method is implemented in the form of a user-friendly software that allows unedited deflection time histories from the FWD test to be used as an input to the back-analysis. The backcalculation scheme developed in this study is based on the Artificial Neural Network (ANN) approach and employs a three-dimensional multilayer viscoelastic dynamic model as a predictive tool.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Implementation Plan was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200225pdf

Report #2002-26

Principal Investigator:
Lee Munnich, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 183

Contract Period:
November 1, 2000 to April 30, 2002

Funding:
$320,000 Guidestar
$180,000 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Transportation Technologies for Sustainable Communities

Description:
This collection of studies addresses legal and institutional issues around applying telecommunication, wireless and GPS technologies to transportation, with the focus on development of sustainable communities.

Conclusions:
This collection of studies addresses legal and institutional issues around applying telecommunication, wireless, and GPS technologies to transportation, with a focus on the development of sustainable communities.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200226.pdf

Report #2002-27

Principal Investigator:
Thomas Smith, University of Minnesota

CoPrincipal Investigator:
Peter Hancock, University of Minnesota

Technical Liaison:
Craig Shankwitz, University of Minnesota

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 111

Contract Period:
April 12, 1999 to July 31, 2001

Funding:
$34,800 Guidestar
$8,700 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Effects of Vision Enhancement Systems (VES) on Older Drivers' Ability to Drive Safely at Night & in Inclement Weather

Description:
This report presents a human-factor analysis of the visual properties of an actual in-vehicle heads-up display (HUD) system used for the Highway 7 project.

Conclusions:
The HUD system is intended to improve driving performance in conditions of limited visibility. The HUD system projects lines that correspond to the sides and center line of the roadway onto the windshield of the vehicle, thus aiding the driver in times of low visibility. The author found that the simple, monochromatic image avoided many problems associated with other more complicated HUD designs and that the use of conformal imagery (projecting the image over the actual view) enhanced the effectiveness of the system.

This analysis complements the analysis of simulated in-vehicle head-up display done by Caird, Horrey, Chugh, and Edwards. Their report, "The Effects of Conformal and Non-Conformal Vision Enhancement Systems on Older Driver Performance," is included as an appendix to this report.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200227.pdf

Report #2002-28

Principal Investigator:
Timothy Larson, University of Minnesota

Technical Liaison:
Erik Wolhowe, Mn/DOT, Office of Bridges

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
73596 WO 191

Contract Period:
6/1/1995
to August 31, 1996

Funding:
$28,000
LRRB

Program:
CY1996/CY1997
LRRB
INV 709

INV 709: Evaluation of Retrofit Procedures for Nail-Laminated & Stringer Bridges

Description:
The retrofitting and testing of two bridges in Sibley County were conducted. The bridges were made wider and stronger by adding a transverse bridge deck over the existing deck and substructure. Retrofit bridges are expected to last 20-40 years. Retrofitting can be a very cost effective means for maintaining bridges.

Conclusions:
Many of the 1,400 timber bridges in Minnesota need to be improved to meet present day standards. When the desired service level can be attained by widening a bridge six feet or less, a retrofit can be done by placing a second, wider, transverse deck onto the existing deck and substructure. Bridge components must be carefully inspected prior to a retrofit project. A retrofitted timber bridge is expected to last an additional 20–40 years.

Implementation:
Specifications for laminated bridges were modified to require that the moisture content at the time of construction needed to be less than 19%. For existing bridges, the annual inspection routine was modified to include load testing the post tensioning system.
At the February 28, 1998 LRRB meeting, they declined to fund a new timber bridge research proposal. They felt that timber bridges were not cost effective and recommended a strategic decision not to fund any future proposals related to timber bridges. Minnesota has expertise for technical assistance. It was stated that when the state bonding came through that it was cheaper to replace the bridges than to retrofit them. In August of 1999, a survey was sent to county engineers who received reports 1998-07, 1998-07S, and 1999-03 in order to measure the usefulness of the research and any benefits derived. At a Technology Transfer "Bridge Maintenance Seminar" held December 6th, 2001 at St. Cloud, Minnesota, county and US Forest Service personnel were interested in timber bridge maintenance and training since there are timber bridges still in operation. The Mn/DOT Bridge Office said two main points come out of this research that they will focus on. First, in regards to Transverse Stiffener Beams, the code used to design timber bridges changed and it now requires more transverse stiffener beams. This change coincides with what the research suggests. The Bridge Office notified the consulting firm that designs most of the timber bridges for the county system. Second, in regards to Moisture Content, the Bridge Office discussed this with the consulting firm previously mentioned and they are working on ways to insure the lower moisture content. The current Mn/DOT specification requires a maximum of 19 percent, but this standard is not always met.

Implementation Outcome:
Change without measures

Report Located At: http://www.lrrb.gen.mn.us/pdf/200228.pdf

Related Projects:
LRRB INV699 "Timber Bridge Inspection" 71391 WO 126 Report #2002-34
LRRB INV706 "Evaluation of Timber Bridge Wear Surfaces" 74708 WO 8 Report #1998-07
LRRB INV731 "Equilibrium Moisture Content of Wood in Minnesota Timber Bridges" 74708 WO 66 Report #1999-03
LRRB INV694 "Cold Temperature Effects on Stress Laminated Bridge Decks" 71263 WO 121 Report #1998-03
LRRB INV687 "Analysis of The Bridge Retrofit System Developed by Gene Isackson" 68575 WO 66 Report #94-16
LRRB INV730 "Transverse Stiffener Beams in Long. Nail LamTimber Decks" 74708 WO 65 Report #2003-12

Report #2002-29

Principal Investigator:
Nikolaos Papanikolopoulos, University of Minnesota

Technical Liaison:
Kristi Billiar, Mn/DOT, Office of Transit

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 122
Contract Period:
October 17, 2000 to April 30, 2002

Funding:
$44,0850 Guidestar
$11,020 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Pedestrian Control Issues at Busy Intersections and Monitoring Large Crowds

Description:
This report addresses the problem of monitoring vehicles, pedestrians, and crowds in outdoor urban settings. The authors propose a vision-based monitoring system that captures not only speed and direction, but also position, velocity, acceleration/deceleration, bounding box, and shape features. Algorithms are used to determine direction of crowd movement, crowd density, and mostly used areas. The authors foresee that this system could be used for intersection control, collection of traffic data, and crowd control.

Conclusions:
This paper presents a vision-based system for monitoring crowded urban scenes. The approach employs an effective detection scheme based on optical flow that can locate vehicles, individual pedestrians, and crowds. The detection phase is followed by the tracking phase that tracks all the detected entities. Traffic objects are not simply tracked but a wealth of information is gathered about them (position, velocity, acceleration/ deceleration, bounding box, and shape features). Potential applications of our methods include intersection control, traffic data collection, and even crowd control after athletic events. Extensive experimental results for a variety of weather conditions are presented. Future work will be focused on methods to deal with shadows and occlusions.

Implementation:
The information obtained from this project has been used in additional research on crowd control and behavior.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200229.pdf

Report #2002-30

Principal Investigator:
Bjorn Birgisson, University of Florida

Technical Liaison:
Ruth Roberson, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
79080

Contract Period:
December 12, 2000 to February 28, 2002

Funding:
$42,000
STIP

Program:
Mn/DOT Transportation Research Program

Evaluation of Water Flow Through Pavement Systems

Description:
This report focuses on an unsaturated flow model for research on the effects of moisture in pavement, which is a more comprehensive approach for determining roadway drainage. Results establish that SEEP/W software is a valuable tool for modeling unsaturated flow and that time to drain calculations based on unsaturated flow theory will generally be longer than time to drain evaluated under saturated flow assumptions.

Conclusions:
The results obtained in this study show that pavement drainage should generally be modeled using unsaturated flow theory. The quality of the predictions is heavily dependent upon the accuracy of both the soil water characteristic curve and the hydraulic conductivity curve obtained in the laboratory, as well as on having a detailed knowledge of field conditions. In addition to having detailed water table measurements throughout the cross section to be analyzed, it is also important to have knowledge of the variation of moisture contents in both the vertical and horizontal plane. In particular, horizontal arrays of Time Domain Reflectometry (TDRs) around key interfaces could play a major role in furthering the understanding of unsaturated flow through flexible pavements obtained in this project.

Implementation:
The report addresses a number of key issues with drainage and drainability, including the illustration of clear evidence that pavements drain under unsaturated conditions. This finding has a wide variety of implications, including how to build better draining pavements, and what type of materials should be used in bases and subgrades to optimize drainability.

Mn/DOT continues to use the findings of this report and the SEEP/W software to successfully model drainage and flow of water through pavement systems.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200230.pdf

Report #2002-34

Principal Investigator:
Robert Seavey, University of Minnesota

Technical Liaison:
Erik Wolhowe, Mn/DOT, Office of Bridges

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
71391 WO 126

Contract Period:
October 11, 1993 to August 31, 1995

Funding:
$49,635.50 LRRB

Program:
CY1994 LRRB INV 699

Dynamic and Resilient Modulus of Mn/DOT Asphalt Mixtures

Description:
This study reviewed both new and traditional techniques for inspecting decaying wood on timber bridges. Newer, nondestructive technologies include stress wave timber or Resistograph drill and infrared thermography. These methods offer many advantages, but they are still expensive and time consuming. Traditional inspection methods might provide the best alternative.

Conclusions:
These timber bridges are located in rural, low traffic settings that do not justify the expense of replacement. Extending the life of these bridges will not only save communities money, but will ensure continuous bridge service. This study reviewed both new and traditional techniques for inspecting decaying wood on timber bridges. Newer, nondestructive technologies examined include De-K Tector, stress wave timer, Sylvatest, PoleTest, pile length assessment, hammer sounding, shigometer, Resistograph, core and bore sampling, probing, moisture meters, and infrared thermography. These methods offer many advantages, but are still expensive and time consuming. Traditional inspection methods might be the best alternative in most situations. The researchers recommend inspecting older bridges every three years and newer bridges every five years, with more careful evaluation of areas that show wood decay. The researchers conclude that the best way to pass on knowledge about timber bridge inspection is through hands-on seminars.

Implementation:
Specifications for laminated bridges were modified to require that the moisture content at the time of construction needed to be less than 19%. For existing bridges, the annual inspection routine was modified to include load testing the post tensioning system. The Mn/DOT Bridge Office said two main points come out of this research that they will focus on. First, in regards to Transverse Stiffener Beams, the code used to design timber bridges changed and it now requires more transverse stiffener beams. This change coincides with what the research suggests. The Bridge Office notified the consulting firm that designs most of the timber bridges for the county system. Second, in regards to Moisture Content, the Bridge Office discussed this with the consulting firm previously mentioned and they are working on ways to insure the lower moisture content. The current Mn/DOT specification requires a maximum of 19 percent, but this standard is not always met.

Implementation Outcome: Change without measures

Report Located At: http://www.lrrb.gen.mn.us/pdf/2002.pdf

Related Projects:
LRRB INV706 "Evaluation of Timber Bridge Wear Surfaces" 74708 WO 8 Report #1998-07
LRRB INV731 "Equilibrium Moisture Content of Wood in Minnesota Timber Bridges" 74708 WO 66 Report #1999-03
LRRB INV694 "Cold Temperature Effects on Stress Laminated Bridge Decks" 71263 WO 121 Report #1998-03
LRRB INV687 "Analysis of The Bridge Retrofit System Developed by Gene Isackson" 68575 WO 66 Report #94-16
LRRB INV709 "Evaluation of Retrofit Procedures for Nail-Laminated and Stringer Bridges" 73596 WO 191 Report #2002-28
LRRB INV730 "Transverse Stiffener Beams in Longitudinally Nail Laminated Timber Decks" 74708 WO 65 Report #2003-12

Report #2002-35

Principal Investigator:
John Carmody, University of Minnesota

CoPrincipal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Ron Erikson, Mn/DOT, Office of Technical Support

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
74708 WO 118

Contract Period:
November 1, 1999 to May 31, 2002

Funding:
$50,000
STIP

Program:
Mn/DOT Transportation Research Program

The Effect of Centerline Treatments on Driving Performance *(Phase II)*

Description:
Researchers examined centerline treatments and possible recommendations for Super Two Highway guidelines. The current US standard (12-foot lane / 4-inch dashes) was compared with combinations of wider lanes, wider dashes, and buffer areas.

Conclusions:
The current US standard (12-foot lane / 4-inch dashes) was compared with combinations of wider lanes, wider dashes, and buffer areas.

With each of the centerline treatments examined, participants kept the left side of the vehicle in the approximate center of the lane. All treatments resulted in shifting the center of the lane farther from the centerline than it was in the standard condition.

Two conditions appear to be most effective in keeping drivers away from the centerline:
1) 14-foot lanes with both longitudinal rumble strips and 4-inch wide dashes marking the centerline, and
2) 12-foot lanes with 4-foot buffer marked by 4-inch wide dashes.

However, implementing any of the centerline treatments should result in vehicles driving farther from the centerline, thus making it less likely that drivers will meet an oncoming vehicle.

Data was gathered in a driving simulator. Further testing should be conducted in real driving situations.

Implementation:
The research was deemed useful by Mn/DOT in making the decision for the Hwy. 12 project. The findings demonstrated what not to use and gave design engineers a tested alternative. The segment of Hwy. 12 using the centerline treatments will be watched closely, but there are no plans for a formal measurement process.

Implementation Outcome:
Change without measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200235.pdf

Related Reports:
"Investigating the Effect of Roadway Design on Driver Behavior" 74708 WO 28 Report #1999-10

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2001 Mn/DOT, LRRB and Pooled Fund

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2001-10	Fatigue Evaluation of the Deck Truss of Bridge 9340	246
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2001-24	Population and Employment Density and Travel Behavior in Large U.S. Cities	260

Report #2001-01

Principal Investigator:
Susan Henderson, Henderson Associates

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
N/A

Expediting the Delivery of Transportation Projects - Proceedings

Description:
On Oct. 22-24, 2000, 59 leaders from consulting engineering firms, Mn/DOT and the Department of Administration gathered in Minneapolis, MN to participate in a workshop to address their fundamental working relationship and the processes related to the consultant program. The workshop was convened by the University of MN's Center for Transportation Studies and sponsored by Mn/DOT and the Consulting Engineers Council of MN. The workshop objective was to discover new ways for Mn/DOT and the consulting industry to expedite the delivery of transportation projects that benefit the public.

Conclusions:
Leaders in the private and public sector, seeking to address the challenges of the future with fresh approaches and new thinking, met to:

1) Understand the central role of the Consultant Program in the "Big Plan"
2) Analyze the problems facing government and private users of the Consultant Program
3) Examine the best practices in Consultant Programs from other state Department of Transportation (DOTs) and lesions they may hold for Minnesota
4) Develop a blueprint to make the Consultant Program "better-faster-cheaper" and more satisfying to work in

Four groups of Mn/DOT stakeholders, two groups of consulting firms and an administration group were formed to identify issues and challenges in the "as is" consulting process from their perspectives. The major issues and challenges were recorded and reported to the larger workshop.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200101.pdf

Report #2001-02

Principal Investigator:
Dave Janish,
Office of Materials

CoPrincipal Investigator:
N/A

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
N/A

2000 Pavement Management Annual Report

Description:
Mn/DOT's Pavement Management Unit conducts a biennial pavement condition assessment of the trunk highway system using an automated video and laser equipped van. The pavement condition data is then reduced to 3 pavement indices, PSR, SR and PQI. This report was based on data collected during 1999 and 2000.

Conclusions:
The PQI value is derived from two other indices of pavement condition. Although it is useful to have one composite number like the PQI to characterize condition, the two indices from which it is derived may afford greater insight into the rate and mechanisms of deterioration, as well as the effectiveness and cost of maintenance and rehabilitation. The Surface Rating (SR) indirectly measures the condition of the pavement structure based upon its surface appearance. The Present Serviceability Rating (PSR) measures the smoothness of ride.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200102.pdf

Report #2001-03

Principal Investigator:
Eil Kwon,
University of Minnesota

Technical Liaison:
Jim Aswegan,
Mn/DOT, Metro

Administrative Liaison:
Ron Cassellius,
Mn/DOT

Contract:
74708 WO 45

Contract Period:
June 1, 1998
to August 31, 1999

Funding:
$17,500 Metro
Traffic Management
$500 STIP

Program:
Guidestar
and
Mn/DOT
Transportation
Research Program

Technical support for implementation of freeway network simulation software

Description:
This report summarizes the results from the technical support and testing of the freeway traffic simulation software developed at the University of MN. The case studies indicate that the simulation software can be applicable in evaluating alternative design and operational strategies for a given set of demands.

Conclusions:
The simulation software was tested in this research through two sets of case studies involving the HOV lane and ramp metering simulation modules. The HOV land case study used a section of the I-94 freeway and evaluated the performance of alternative HOV lane strategies with different sets of demand and HOV proportions. The ramp metering case study compared the performance of the current Mn/DOT metering policy with that of no-metering option for a 16 mile section of the northbound 169 freeway with increased demand. The results from these case studies, described in detail in this report, indicate that the simulation software can be applicable in evaluating alternative design and operational strategies for a given set of demand.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200103.pdf

Related Projects:
"Enhancements of the Kronos Simulation Package and Database (Phase III)" 72077 WO 139, Report #1999-11

Report #2001-04

Principal Investigator:
Timothy Keller, Iowa State University

Technical Liaison:
David Larson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Ron Cassellius, Mn/DOT

Contract:
74995 WO 1

Contract Period:
December 21, 1998 to March 31, 2001

Funding:
$74,633
STIP

Program:
Mn/DOT Transportation Research Program

Aesthetic Initiative Measurement System

Description:
For the Aesthetic Initiative Measurement System (AIMS) project, researchers developed and tested the instruments and protocols that Mn/DOT uses to understand and document how travelers perceive the attractiveness of Minnesota's transportation corridors. The consistency of AIMS results with previous studies of other landscape settings suggested that AIMS results are valid and could be replicated in other urban highway routes and with rural highways.

Conclusions:
In summer 1999, researchers collected quantitative and qualitative data for three cities: Rochester, Twin Cities, and Duluth, Minnesota. Four key topics produced highly noticeable aesthetic effects to the travelers: maintenance, planting design, structural design, and vistas from the highway. The consistency of AIMS results with previous studies of other landscaped settings suggested that AIMS results are valid and could be replicated in other urban highway routes and with rural highways.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200104.pdf

Report #2001-05

Principal Investigator:
Ann Johnson, Professional Engineering Services, Ltd.

Technical Liaison:
Roger Olson, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Kessig, Mn/DOT

Contract:
78443

Contract Period:
2/24/1999 to 9/30/2001

Funding:
$16,954 Commissioner's Plan
$3,760
$28,195 for Web Site

Program:
Implementation of Research Findings (1999-2000)
INV 645
Task 15

Asphalt Pavement Maintenance Field Guide

Description:
This field manual provides guidelines for preventive asphalt pavement maintenance techniques for a variety of distresses and conditions. The guide covers crack treatments (clean and seal, rout and seal, full-depth crack repair); surface treatments (fog seal, seal coat, thin hot-mix overlays); and pothole patching and repair (cold-mix asphalt, spray injection patching, hot-mix asphalt, slurry or microsurfacing material).

Conclusions:
The "Asphalt Pavement Maintenance Field Guide" is a laminated booklet containing preventive asphalt pavement maintenance techniques for a variety of stresses and conditions. The guide is condensed from the Best Practices Handbook on Asphalt Pavement Maintenance, manual 2000-04. The guide covers crack treatments (clean and seal, rout and seal, full-depth crack repair); surface treatments (fog seal, seal coat, thin hot-mix overlays); and pothole patching and repair (cold-mix asphalt, spray injection patching, hot-mix asphalt, slurry or microsurfacing material).

Implementation:
Minnesota's LTAP program holds a 6 hour class every year on this subject.

Implementation Outcome:
No Close-out memo was written.

Report Located At:
Call the Research Services Section at 651/282/2274 to request a copy of Report #2001-05.

Report #2001-06

Principal Investigator:
Julie Vandenbossche, Mn/DOT, Office of Materials

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
MnROAD

A Review of the Curing Compounds and Application Techniques Used by Mn/DOT for Concrete Pavement

Description:
This report presents the results of a 1998 study to evaluate Mn/DOT's concrete pavement curing requirements. It summarizes the findings of this study and the resulting changes that Mn/DOT made to its concrete pavement curing specifications.

Conclusions:
Researchers first performed an assessment of the effectiveness of various compounds frequently used on state-funded projects, as well as an assessment of the test methods used to evaluate these compounds. Based on the findings of the study's first phase, Mn/DOT changed its curing specifications and implemented the changes during the 1999 construction season.

Researchers also reviewed methods used by the contractors to ensure the application of a uniform coat of acceptable thickness and made recommendations for improving these methods. This report summarizes the findings of this study and the resulting changes that Mn/DOT made to its concrete pavement curing specifications. Recommendations for further improvements also are provided.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200106.pdf

Report #2001-07

Principal Investigator:
Julie Vandenbossche, University of Minnesota

Technical Liaison:
Paul Keranen, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
N/A

Contract Period:
N/A

Funding:
$25,000
LRRB

Program:
CY1997 LRRB
INV 729

The Construction of US-169 & I-94 Experimental Thin & Ultra-Thin White Topping Sections in MN

Description:
This report presents the results of research project to investigate the design and performance of thin and ultra-thin whitetopping.

Conclusions:
This report presents the results of research project to investigate the design and performance of thin and ultra-thin whitetopping. To learn more about whitetopping, Mn/DOT constructed a whitetopping project consisting of six test sections on I-94 at a research facility and three test sections at intersections on US-169 at Elk River.

This report includes a brief description of Mn/DOT history with whitetopping and a detailed description of the construction of the heavily instrumented whitetopping test sections of I-94 and US-169. All concrete mixes contained either polypropylene and polyolefin fibers. The compressive strength, flexural strength, Poisson's ratio, and elastic modulus were measured for these mixes, and the results are provided.

Implementation:
LRRB's Research Implementation Committee funded a project titled "Best Practices Guidelines for Thin and Ultra-Thin Whitetopping" Task 4

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200107.pdf

Report #2001-08

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
Darab Bouzarjomehri, Mn/DOT, Office of Traffic, Security and Operations

CoTechnical Liaison:
Loren Hill, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Bill Bunde, Mn/DOT

Contract:
74708 WO 7

Contract Period:
June 17, 1996 to December 31, 1998

Funding:
$5,326 COPTRS
$31,971.20 Guidestar
$2,666.80 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Development & Testing of Methods for Estimating the Impact of Safety Improvements

Description:
This report describes a Bayesian method for estimating accident rates at individual sites, which takes into account the fact that the total traffic count usually used to measure exposure is generally not known with certainty.

Conclusions:
The first step involves deriving an approximation for the probability distribution of total traffic conditioned on a short count sample. This approximation is then used to drive a Bayes estimator of a site's accident rate, conditioned on an accident count, a short count sample, and the total traffic approximation.

The method then uses Gibbs sampling to compute accident rate estimates. Tests based on actual accident and traffic data revealed that accident rate estimates based on a two-week traffic sample area are almost as accurate as estimates based on full traffic counting, but that uncertainty in the estimated accident rates increase by 20 to 50 percent when using a two-day count sample.

Implementation:
The implementation recommendations should be viewed as long term as opposed to short since, although promising statistical methods do exist, they are not available in user friendly implementations and their correct use requires statistical knowledge beyond that normally taught to traffic engineers. While this research developed a methodology that provided a way to achieve more precise traffic counts and accident rates, the outcome was to increase the body of knowledge and not cause any change to the way Mn/DOT does business.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200108.pdf

Report #2001-09

Principal Investigator:
Eric Embacher, Mn/DOT, Mendota Heights - Construction

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
N/A

Construction Report on the Installation of Retrofit Dowel Bar Test Sections on TH 23

Description:
A section of Trunk Highway 23 near Mora, Minnesota, underwent concrete rehabilitation in 1998, which included the installation of retrofit dowel bars over a portion of the project.

Mn/DOT established several different test sections to evaluate the performance of different dowel bar configurations, group materials, and dowel bar lengths. During dowel bar installation, researchers monitored and evaluated construction procedures. They also conducted pavement testing before and after installation of the retrofit dowel bars to determine any immediate improvements to the joint performance.

Conclusions:
There has been no significant difference between the performance of the different retrofit test sections or the control section. The only noticeable difference between the doweled and undoweled sections is the joint load transfer, which is expected.

After only two years, the undoweled section has not shown any recurrent faulting and the ride quality is comparable to the doweled sections. Monitoring of the test sections will continue on a yearly basis to determine the joint load transfer, faulting and ride quality over time. Visual inspections will also continue to be performed to determine the development of any deterioration.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200109.pdf

Report #2001-10

Principal Investigator:
Robert Dexter, University of Minnesota

Technical Liaison:
Duane Green, Jr., Mn/DOT, Office of Bridges

Administrative Liaison:
Norm Cordes, Mn/DOT

Contract:
74708 WO 124

Contract Period:
May 13, 1999 to August 31, 2000

Funding:
$70,000 Consultant Services

Program:
Bridge

Fatigue Evaluation of the Deck Truss of Bridge 9340

Description:
This research project resulted in a new, accurate way to assess fatigue cracking on Bridge 9340 on I-35, which crosses the Mississippi River near downtown Minneapolis.

Conclusions:
The research involved installation on both the main trusses and the floor truss to measure the live-load stress ranges. Researchers monitored the strain gages while trucks with know axle weights crossed the bridge under normal traffic. Researchers then developed two-and three-dimensional finite-element models of the bridge, and used the models to calculate the stress ranges throughout the deck truss.

The bridge's deck truss has not experienced fatigue cracking, but it has many poor fatigue details on the main truss and floor truss system. The research helped determine that the fatigue cracking of the deck truss is not likely, which means that the bridge should not have any problems with fatigue cracking in the foreseeable future.

As a result, Mn/DOT does not need to prematurely replace this bridge because of fatigue cracking, avoiding the high costs associated with such a large project.

The research also has implications for other bridges. The project verified that the use of strain gages at key locations combined with detailed analysis help predict the bridge's behavior. In addition, the instrumentation plan can be used in other similar bridges.

Implementation:
The report showed that fatigue damage in the truss is possible but is not likely. As a result, the truss is not in need of replacement earlier than planned. However, the report did identify some members which were more susceptible to fatigue damage than others. This information will allow MnDOT to make contingency plans to repair or replace any of those members in the event that one of them start to fail.

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200110.pdf

Report #2001-11

Principal Investigator:
Jerry Geib, Mn/DOT, Office of Materials

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
MnROAD

1999 Statewide Micro Surfacing Project

Description:
This project introduced the use of micro surfacing as a pavement preventive maintenance surface treatment and tested different methods of using micro surfacing to correct or prevent defects in existing pavements.

Conclusions:
Application and testing revealed that the fast-moving micro surfacing process minimizes the amount of down time for traffic; does an excellent job of reestablishing cross sections; fills ruts; improves ride quality; increases friction numbers; and provides an excellent background for pavement markings. It does not seal reflective cracks, but has generated some concerns about increased traffic noise, and does not work favorably for smoothing humps in pavement.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200111.pdf

Report #2001-12

Principal Investigator:
David Kittelson, University of Minnesota

CoPrincipal Investigator:
Winthrop Watts, University of Minnesota

Technical Liaison:
Marilyn Jordahl-Larson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Bill Bunde, formerly Mn/DOT

Contract:
74708 WO 120

Contract Period:
June 11, 1999 to June 30, 2001

Funding:
$57,581
STIP

Program:
Mn/DOT Transportation Research Program

Fine Particle (Nanoparticle) Emissions on MN Highways

Description:
This study examined the physical characteristics of combustion aerosols found on Minnesota highways. It emphasized the characterization of nanoparticles (less than 50 nm) with the goal of providing real-world data for the development of engine laboratory test methods.

Conclusions:
On-road particulate matter emissions ranged between 104 to 106 particles/cm3 with the majority of the particles by number being less than 50 nm in diameter. High-speed traffic produced high nanoparticle number concentrations and diesel traffic further increased number concentrations. At high vehicular speeds, particulate matter emissions increase because of higher engine load and fuel consumption.

Measurements made at speeds less than 20 mph showed lower number but higher volume concentrations and larger particles. Measurements made 10-30 m from the highway in residential areas approached on-road concentrations with similar size distributions and high concentrations of nanoparticles. Lower concentrations and larger particles were observed in residential areas 500 to 700 m from the highway.

Fuel specific and particle/mi emission rates were estimated from data collected on two different days. The particle/mi emissions were about an order of magnitude greater than published figures but mass emission rates compared well with published values. However, colder temperatures, different dilution and sampling conditions and different instrumentation could explain our increased estimates.

Implementation:
This research was cancelled in spite of numerous efforts to move forward In this case, Mn/DOT's needs could not be met through the researchers original proposal. The technical panel, MnDOT and CTS staff, with the researchers worked hard to hammer out the issues delaying progress on an acceptable work plan.. An excerpts from an email dated February 4, 2003, written by the Technical Liaison, sums up the issue:

"It is clear that Dr. Kittelson's work is highly regarded by federal government agencies and the academic community. Unfortunately his work as currently proposed does not fall into any identifiable Mn/DOT core function or research priority. Given the current budget crisis and Mn/DOT's instructions to focus staff and funding on top priority core functions, it is recommended that Dr. Kittelson withdraw his funding requests until such time as the State financial crisis is resolved and his proposed work fully addresses Mn/Dot's core functions, technical needs and research priorities."

Although this type of research advances knowledge and will continue to be of value to Mn/DOT, at the present time Mn/DOT's technical experts feel that any research should include chemical analysis of particles in order to meet Mn/DOT needs. Given the level of interest and dynamic nature of research in this field, along with the anticipated advancement of knowledge, any future research should include a full discussion of the state-of-the-research at the time of the proposed work and consider chemical analysis of particles in that context.

Implementation Outcome:
Knowledge gained

Report Located At: http://www.lrrb.gen.mn.us/pdf/200112.pdf

Report #2001-13

Principal Investigator:
Cameron Kruse, Braun Intertec Corporation

Technical Liaison:
Larry Read, Formerly City of Fairmont

Administrative Liaison:
Dave Johnson, formerly Mn/DOT

Contract:
78443

Contract Period:
2/24/1999 to 9/30/2001

Funding:
$9,604 LRRB

Program:
Implementation of Research Findings (1999-2000)
INV 645
Task 6

Evaluation of the Method, Cost and Value of Sealing Systems for Manhole Rings (RIC Task #6)

Description:
This study looks at the experience of Minnesota cities and other past research in evaluating the many available methods to repair rings and in recommending construction and repair methods that minimize the risk of damage.

Conclusions:
Poor construction of manholes and damage from frost heaving cause most failures. When repairs are necessary, survey results suggest three methods with the best cost/value ratios: The Cretex Internal Chimney Seal ™, Flex-Seal Utility Sealant™, and Infi-Shield™ seal. One method still under evaluation, rings made of High-Density Polyethylene (HDPE), show some initial indication of success. While lower in initial cost, other methods are less lasting, resulting in a poor cost/value ratio.

Methods also must accommodate the tensile stresses and elongation strains associated with frost heaving through ice lenses. Materials must be elastic enough at sub-freezing temperatures to stretch without breaking when frost heaving opens a joint.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200113.pdf

Report #2001-14

Principal Investigator:
Vladimir Cherkassky, University of Minnesota

Technical Liaison:
Jamie Day, Mn/DOT, Office of Land Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 141

Contract Period:
January 18, 2000 to April 30, 2001

Funding:
$17,500 Guidestar
$17,500 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Image Compression for Storage and Transmission of Digitized Images

Description:
This project researched image compression methods for storage and transmission of digital images at Mn/DOT.

Conclusions:
Researchers compared the performance of several commercial and research methods for image compression based on the "typical" image provided by the Mn/DOT Office of Land Management. They also surveyed some new image compression methods based on wavelet thresholding. The report details the analyses and comparisons and includes recommendations.

Researchers choose MrSID, a commercial software package for image compression, as a suitable method for the needs of Mn/DOT's Office of Land Management. MrSID uses a wavelet transform-based algorithm to achieve both the efficient storage and retrieval of large digital images. Its main practical advantages include improved utilization of storage and transmission resources and a multi-resolution browsing capability. MrSID can selectively decompress a portion of an image by zooming at different levels of detail.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200114.pdf

Report #2001-15

Principal Investigator:
Andrew Drescher, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 90

Contract Period:
July 8, 1998 to October 31, 2000

Funding:
$50,000 LRRB

Program:
CY1996 LRRB INV 713

The Use of Geosynthetics To Reinforce Low Volume Roads

Description:
This report presents the results of a study that investigated the reinforcement function of geosynthetics for typical Minnesota low-volume roadways. Researchers conducted a series of numerical simulations using the finite difference program FLAC.

Conclusions:
The numerical tests consisted of a static, circular nine kip loading over a variety of typical surfaced and unsurfaced road cross sections that were reinforced with geotextiles and geogrids. Researchers used elastic and elasto-lastic models with
frictional interfaces to simulate the layered roadway system.

The results of the study indicate that the addition of a geosynthetic does provide reinforcement to the roadway as long as the geosynthetic is stiffer than the subgrade material. However, for most of the cases studied, the benefit in terms of
deflection reduction, was very small. Only for the poorest quality subgrades was the reinforcement benefit substantial.

Implementation:
These projects were basic research that built the base for more practical research leading to implementation. There is still much to be learned about geotextiles and geogrids and the benefits associated with their use for different purposes. Since these projects were funded by the Local Road Research Board, it is important to look at how they benefited local engineering operations. The findings of portions of this research have been verified in a survey of county engineers conducted for Inv. 772, published in "Special Practices for Design and Construction of Subgrades in Poor, Wet and/or Saturated Soil Conditions" by Gene Skok Report No. 2003-36.

Worth mentioning is the Geosynthetics Design Guide available on the Local Road Research Board web site which provides hot links to specifications via Mn/DOT's web site. As specifications are updated, based on research, local government designers have access to current information.

Information from this research was included in a national pooled fund project lead by the Maine DOT. FHWA TPF-5(010) will determine whether geosynthetics (geogrids and geotextiles) can be used to increase the structural capacity of pavements typically constructed by state DOTs.

The findings published in the above reports were also used in research done by Dr. Steven W. Perkins, Montana State University who published the following:

1) "Mechanistic-Empirical Modeling and Design Model Development of Geosynthetic Reinforced Flexible Pavements", FHWA/MT-01-002/99160-1A, November 2001
2) "Numerical Modeling of Geosynthetic Reinforced Flexible Pavements", FHWA/MT-01-003/99160-2, November 2001
3) "Mechanistic-Empirical Modeling and Design Model Development of Geosynthetic Reinforced Flexible Pavements", FHWA/MT-01-002/99160-1, November 2001.

Dr. Perkins recommendations are being used indirectly to develop a national code with the potential for large cost savings.

Regarding future research, other beneficial effects should be considered when separation and bearing capacity during construction are of concern, as this was not investigated. Also, the authors recommended conducting further research regarding the cost/benefit issues of the use of geosynthetics in low volume roads.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200115.pdf

Related Project:
LRRB INV 724 "Fabric for Reinforcement and Separation in Unpaved Roads" 74708 WO 12

Report #2001-16

Principal Investigator:
Arturo Schultz, University of Minnesota

CoPrincipal Investigator:
Mark Snyder, University of Minnesota

Technical Liaison:
Paul Rowekamp, Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 121

Contract Period:
June 21, 1999 to December 31, 2000

Funding:
$56,689
STIP

Program:
Mn/DOT Transportation Research Program

Condition and Durability of Segmental Concrete Block Retaining Walls Along Roadways in Minnesota

Description:
This research project assesses the nature and extent of premature deterioration of segmental concrete block retaining walls (SCBRWs) along roadways in the Minneapolis-St. Paul area.

Conclusions:
Researchers conducted a two-stage condition survey on 104 SCBRWs. The first stage, a general distress survey, focused on determining the type, severity, and extent of distresses present. The second stage, a peak winter survey, assessed the extent of snow/ice cover and exposure to winter sun.

According to research results, only 7 percent of the SCBRWs surveyed were in poor or very poor condition. But researchers observed many distress types in 50 percent or more of the walls surveyed, including freeze-thaw damage, scaling, manufacturing flaws, and efflorescence.

Freeze-thaw damage and scaling were most highly associated with decreases in overall wall condition. Efflorescence and freeze-thaw damage were found to be at least partly dependent upon SCBRW age and block manufacturer. Durability problems appear to be directly related to the lack of durability of the block units, which suggests problems with the use of inadequate mix designs, non-durable aggregate, and/or inadequate curing procedures.

The report includes recommendations to address possible deficiencies in manufacturing processes and quality.

Implementation:
The impacts of implementation are too early to measure, since the real benefit will be increased durability of the SCBRWs using the new specifications. A follow-up study in five to ten years could compare results with the data collected during this research project and be translated into quantifiable measures. The 2003 yearly web statistics report for the LRRB shows 1,165 hits on the final report for the project, indicating that interest is still high.

Implementation Outcome:
Change with no measures

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200116.pdf

Report #2001-17

Principal Investigator:
William Morrish, University of Minnesota

Technical Liaison:
Peggy Reichert, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 154

Contract Period:
December 14, 1999 to September 30, 2001

Funding:
$40,000
STIP

Program:
Mn/DOT Transportation Research Program

Design and Development Principles for Livable Suburban Arterials - (CTS Project #99025)

Description:
This research project investigated the interaction between road section design and adjacent site design by applying livable community principles and developing a set of design criteria that would guide coordination of land use and transportation planning. The research hypothesized a need for a minimum of three roadway prototypes, district planning capabilities, and an integrated land use and transportation planning approach.

Conclusions:
Research findings indicate that a hierarchical network is feasible under the following circumstances:
- The district network assumes arterial segments designed at different speeds.
- Urban design performance criteria are used at the beginning of the planning process to establish quantitative measures.
- Spacing of controlled intersections corresponds to road speed design.
- Urban design templates, keyed to road design speed, are used to guide design of areas adjacent to the intersections.
- The existing development context becomes the basis for balancing activity and moment and for phasing change in the built environment.

Implementation:
Mn/DOT's Implementation Funding Program funded the project "Bike and Pedestrian Implementation Toolbox" IMP 2005, Proposal No. 38, 88310, Report #2006-02

This Bicycle and Pedestrian Toolbox is a synthesis of current research on bicycle and pedestrian planning and facilities providing transportation planners and engineers with information on how to plan and design a bicycle and pedestrian network for a community.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200117.pdf

Report #2001-18

Principal Investigator:
Eric Embacher, Mn/DOT, Mendota Heights - Construction

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
MnROAD

Using Silica Fume Concrete With Full-Depth Bridge Deck in Construction in Minnesota

Description:
This report presents the results of a research project to evaluate the performance of six full-depth silica fume bridge decks, constructed between 1997 and 1999.

Conclusions:
Mn/DOT constructed these decks to compare their performance and constructability in Minnesota, which involves the use of a seven-inch structural slab followed by a two-inch low slump overlay.

Researchers conducted air content and slump field testing, visual inspections, and laboratory testing on chloride permeability, compressive strength, and hardened air system properties. In addition, they compared initial costs between the current deck system and the full-depth silica fume decks.

The overall performance of the silica fume bridge decks has been good; however, two of the bridge decks did have problems related to the development of silica fume balls. Laboratory testing has shown that silica fume concrete performs better in terms of chloride permeability and compressive strength. Field tests have shown that placement of the silica fume concrete is comparable to a conventional concrete mix. Finally, cost comparisons have shown the placement of a full-depth silica fume deck to be slightly lower than the current deck system.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200118.pdf

Report #2001-19

Principal Investigator:
Vaughan Voller, University of Minnesota

Technical Liaison:
Craig Schrader, Mn/DOT, Office of Materials

Administrative Liaison:
Barb Loida, Mn/DOT

Contract:
74708 WO 81

Contract Period:
May 26, 1998 to June 30, 2001

Funding:
$131,000 LRRB

Program:
CY1998 LRRB INV 734

Evaluation of a Field Permeameter to Measure Saturated Hydraulic Conductivity of Base/ Subgrade Materials

Description:
This report is a study on the field use of a permeameter to estimate the saturated hydraulic conductivity of pavement base materials. When the base is thin, permeameter readings are restricted to early infiltration times.

Conclusions:
Field measurements using the permeameter were taken on various highway construction projects, and researchers measured the saturated hydraulic conductivity of samples in the laboratory. Researchers also reviewed theories for converting a field-measured flow rate into a saturated hydraulic conductivity estimate.

By numerical simulation and analysis of the field data, researchers determined an appropriate method for converting the Mn/DOT permeameter flow measurements into estimates of hydraulic conductivity. Variations between the field estimated and laboratory measured hydraulic conductivity are within one order of magnitude. Variations between the field estimate and numerical simulation, however, are much closer.

The study found the Mn/DOT permeameter can be used to obtain a reliable estimate of the base hydraulic conductivity provided that the vase layer is at least 15 cm (six inches) deep. When the base is too thin, permeameter readings are restricted to early infiltration times.

Implementation:
The permeameter can be used to determine the saturated hydraulic conductivity in base layers that are at least 6 inches thick. This will allow determination of Ksat for select granular and thick aggregate bases used in Minnesota construction projects. The saturated hydraulic conductivity value is one of the pieces of the framework that will define the material characteristics and drainage design for Mn/DOT's new pavement design procedure. While immediate implementation is not possible, it may be part of the framework used in the future.

Implementation Outcome:
Knowledge gained

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200119.pdf

Report #2001-20

Principal Investigator:
Rajesh Rajamani, University of Minnesota

Technical Liaison:
William Gardner, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
74708 WO 136

Contract Period:
September 13, 1999 to June 30, 2001

Funding:
$29,500 Guidestar
$29,500 STIP

Program:
ITS and Mn/DOT Transportation Research Program

Fault Diagnostics For Intelligent Vehicle Applications

Description:
This project involved the development of a fault diagnostic system for Safetruck, an intelligent vehicle prototype. The fault diagnostic system continuously monitors the health of vehicle sensors, detects a failure when it happens, and identifies the source of the failure.

Conclusions:
The fault diagnostic system monitors several key components: the Global Positioning System, lateral accelerometer, and yaw-rate gyroscope, which constitute the set of lateral dynamic sensors, as well as the forward-looking radar that measures distance, relative velocity, and azimuth angle to other vehicles and objects on the highway.

To design the project's lateral fault diagnostic system, researchers exploited the model-based dynamic relationships that exist between the three lateral sensors. They verified the system's performance through extensive experiments on the Safetruck.

This project also explored a number of new approaches to creating a reliable fault detection system for radar. Monitoring the radar's health poses a special challenge because the radar measures the distance to another independent vehicle on the highway. In the absence of inter-vehicle communications, the fault diagnostic system has no way of knowing the other vehicle's motion, which means that model-based approaches cannot be used. Experimental results indicate that an inexpensive redundant sensor combined with a specially designed nonlinear filter would provide the most reliable method for radar health monitoring.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200120.pdf

Report #2001-21

Principal Investigator:
Vaughan Voller, University of Minnesota

Technical Liaison:
Tom Hunt, Mn/DOT, Office of Materials

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract:
74708 WO 31

Contract Period:
April 1, 1997 to March 31, 2001

Funding:
$95,000 COPTRS

Program:
Mn/DOT Transportation Research Program

Measurement of Moisture in Aggregate Stockpiles

Description:
This project looked at identifying a practical and accurate field method or probe for measuring the moisture content of aggregates, testing the probe in a hot-mix plant, and developing a control strategy for asphalt oil addition to the mix.

Conclusions:
Researchers identified a suitable commercial probe by reviewing past research and conducting laboratory studies. Testing in the plant showed that this probe could rapidly measure aggregate moisture in plant conditions at the same level of accuracy as gravimetric measurements. Researchers also developed a control strategy for the asphalt oil addition. Testing showed the effectiveness of this control strategy for the asphalt oil addition. Testing showed the effectiveness of this control, in conjunction with commercial probe moisture measurements in the feed bin. A problem with probe operations robustness was identified.

Implementation:
Determining the moisture content in an asphalt mixture can result in several benefits. The contractor may be able to develop a higher quality mixture, achieve higher density in the field, and obtain more consistent volumetrics. These would all result in cost savings in the field and a potential reduction in penalties.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200121.pdf

Report #2001-23

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
Mark Lober, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Bill Bunde, Formerly Mn/DOT

Contract:
74708 WO 36

Contract Period:
April 1, 1997 to September 30, 1999

Funding:
$63,780 COPTRS

Program:
Mn/DOT Transportation Research Program

Sample-Based Estimation of Bicycle Miles of Travel (BMT)

Description:
This project provides a statistically defensible estimate of bicycle-miles of travel (BMT) for at a least substantial portion of the Twin Cities region and assesses the feasibility of monitoring bicycle volumes using sampling methods similar to those used to monitor motor vehicle traffic.

Conclusions:
Researchers used an ArcView database of the Twin Cities street system for the initial sampling frame and extended the database by manually adding information about average annual daily traffic volumes and about on-and off-road bicycle facilities. A stratified random sample of roadways links in Hennepin, Ramsey, and Dakota counties was drawn, and during the months of May through June and August through October 1998, the daytime bicycle volume for one day at each sampled site was obtained using time-lapse video. Researchers then used Cochrane's "combined" estimator to compute an estimate of average daytime BMT for the study area.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200123.pdf

Report #2001-22

Principal Investigator:
Cory Johnson, Mn/DOT, Formerly Office of Metro Maintenance (Contact Chris Beckwith)

Technical Liaison:
N/A

Administrative Liaison:
N/A

Contract:
N/A

Contract Period:
N/A

Funding:
N/A

Program:
N/A

I-35W & Mississippi River Bridge Anti-Icing Project

Description:
This project involved an anti-icing system that was installed on the I-35W & Mississippi River bridge (#9340). Data from sensors and Road Weather Information System (RWIS) determine the driving conditions. Once hazardous conditions are determined to be imminent the sustainable system sprays the anti-icing chemical potassium acetate.

Conclusions:
The I-35W bridge (#9340) was a candidate for this high-tech treatment due to the high incidence of winter traffic crashes on the bridge. The bridge is more susceptible to "black ice" and slippery conditions because of moisture from the Mississippi River's St. Anthony Falls, nearby power plants and industrial facilities, and because of the high volume of traffic on the bridge – year 2000 Average Daily Traffic (ADT) is approximately 139,000 vehicles. The formation of "black ice" is due to the combination of extreme cold and heavy vehicle exhaust from congestion on the bridge. In addition to traffic safety, the anti-icing system also contributes to sustainability, because the chemical used is environmentally less toxic and corrosive than sodium chloride, which traditionally has been used.

Boschung Company Incorporated was hired to design, furnish and install, and support the anti-icing system. Boschung is based in Switzerland and has over 50 years of experience in winter maintenance products and services. Local support was provided out of Brainerd, Minnesota. The system was installed over the course of one year and was completed in December 1999.

Implementation:
Metro District is using the technology and product on the 35E Lexington bridge as part of a construction project. This subject has been discussed at various conferences and training sessions.

Implementation Outcome:
N/A

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200122.pdf

Report #2001-24

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
74708 WO 132

Contract Period:
August 23, 1999 to February 28, 2001

Funding:
$30,000 COPTRS

Program:
Mn/DOT Transportation Research Program

Population and Employment Density and Travel Behavior in Large U.S. Cities

Description:
This research project sought to determine whether high-population density of some other aggregate land use characteristic can be used to create beneficial effects on travel behavior at the level of the entire urbanized area. The study found that land use, at the aggregate level studied in this project, is not a major leverage point in determining overall population travel choices.

Conclusions:
This research involved a comprehensive analysis, considering an unusually large number of factors. Researchers also developed a number of ways to describe aggregate "macro" land use in an urbanized area specifically for this study.

The study found that land use, at the aggregate level studied in this project, is not a major leverage point in determining overall population travel choices. Much policy seems to be based on the belief that relatively small changes to land use will have a big impact on travel choices. The findings here imply just the opposite - that even very big, widespread differences in land use have very little impact on travel behavior, in good ways or in bad ways.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Report Located At:
http://www.lrrb.gen.mn.us/pdf/200124.pdf

List of Completed Projects

Mn/DOT, LRRB and Pooled Fund

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Unpublished Report

Principal Investigator:
James Wilde, Minnesota State University - Mankato

Technical Liaison:
Tom Burnham, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract:
87153

Contract Period:
10/4/2004 to 10/4/2004

Funding:
$30,104
Pooled Fund

Program:
Pooled Fund

Whitetopping Construction and Instrumentation at MnROAD

Description:
To develop and conduct transportation research implementation activities that bring research findings and current technologies to local county and city governments in a manner that facilitates application at the local level.

Conclusions:
This report describes the efforts of the project team in a technical assistance project for Mn/DOT at the MnROAD test facility. The assistance was for the reconstruction, materials testing, and 72-hour pavement profile testing of whitetopping cells at MnROAD in cells 60 through 63. It also included materials testing of cell 54 which was made of concrete with Mesabi Select Aggregate.

The project consisted of pre-construction support and planning, construction support and sample preparation, pavement profile testing during the first 72 hours after placement in the whitetopping sections, and materials testing at 3, 7, and 28 days after placement. The profiling was completed with the assistance of the University of Pittsburgh, who also processed and analyzed the temperature and profile data which is included in the CD-ROM attached to this report.

This report describes the efforts by the project team, the location of all sensors placed in the whitetopping sections, the initial materials and profile testing plans, and the changes to those plans required, based on specific conditions at the project site. This report also includes the materials testing data, provided by the University of Minnesota's Structural Testing Laboratory.

Implementation:
N/A

Implementation Outcome:
N/A

Report Located At:
Report was not published. The final report is part of the MnROAD construction report.

No Deliverable

Principal Investigator:
Wayne Becker, SEH, Incorporated

Technical Liaison:
Ben Zwart, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract:
85962

Contract Period:
3/23/2004 to 6/30/2005

Funding:
$90,000 Office of Maintenance
$30,000 LRRB

Program:
Maintenance Office
CY2004 LRRB
INV 811

Match for Snow Plow Routing Study

Description:
The purpose of this study is to refine the evaluation process utilized by OSM & Associates, Inc., to document the process, and to provide computer software and training manuals for Maintenance personnel to enable them to perform these analyses and evaluations for any maintenance area or maintenance sub-area in the state or county. Several different maintenance areas with differing weather conditions and/or differing performance measures will validate and evaluate these deliverables. The participating areas include District 3 and Crow Wing County. A final part of this work is to deliver sufficient "train the trainer" sessions to enable Maintenance personnel to train others to perform these analyses and evaluations.

Conclusions:
No conclusions as these were training sessions.

Implementation:
Training sessions were held in Districts 3A and 3B, Washington County and Woodbury.

Train the trainer classes were held at Mn/DOT's Central Office on April, 11, 2005 and user training was held in St. Cloud and Baxter on March 24, 2005.

Implementation Outcome:
No Close-out Memo was written.

Report Located At: Report not on web

No Deliverable

Principal Investigator:
Jeff Wright, Castle Rock Consultants

Technical Liaison:
Jim Aamot, Mn/DOT, Formerly Office of Investment Management

Administrative Liaison:
N/A

Contract:
84013

Contract Period:
10/1/2003 to 9/30/2005

Funding:
$27,692 Research Administration
$9,228 LRRB

Program:
Mn/DOT Transportation Research Program

LRRB-ORS Web Site Maintenance

Description:
To provide web site and database maintenance for the LRRB and Research Services web sites.

Conclusions:
N/A

Implementation:
N/A

Implementation Outcome:
N/A

Spring Load Restrictions Report

Principal Investigator:
Laurie McGinnis, University of Minnesota

Technical Liaison:
Anita Benson, Lyon County

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract:
81655 WO 138

Contract Period:
9/13/2004 to 3/31/2005

Funding:
$20,000 LRRB

Program:
CY2004 LRRB INV 818

Spring Load Restriction Study

Description:
The objective of this communication project is to develop a summary report that will take the results from the Spring Load Restrictions research project, combine them with previous related study reports, and communicate the key findings in a way that will facilitate implementation of the results by practitioners and elected officials.

Conclusions:
This analysis is based upon a research project titled "Cost/Benefit Study of Spring Load Restrictions," by Assistant Professor David Levinson, principal investigator, and Assistant Professor Mihai Marasteanu, co-principal investigator, of the University of Minnesota Department of Civil Engineering. Information and comments of pavement experts from Mn/DOT and local government agencies were also incorporated. The larger report mentioned above describes research conducted to determine the economic benefits and costs of spring load restrictions in Minnesota.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out Memo was written.

Final Report was presented to House Transportation committee and sent to City and County Engineers.

Report Located At:
http://www.lrrb.org/pdf/springloadrestrictions.pdf

Related Project:
"Cost/Benefit Study of Spring Load Restrictions" INV 785, 81655 WO 47, Report #2005-15

No Deliverable

Principal Investigator:
Jim Grothaus, University of Minnesota

Technical Liaison:
Scott Bradley, Mn/DOT, Office of Environmental Services

Administrative Liaison:
N/A

Contract:
81655 WO 109

Contract Period:
January 1, 2004 to June 30, 2006

Funding:
$55,000 Consultant Services

Program:
Environmental

Context Sensitive Design

Description:
One, two-day workshop will be delivered to a wide-range of stakeholders. The primary audience for the training session will be Mn/DOT's Project Managers. Representatives from selected stakeholder groups would also be included as participants or presenters in order to provide a range of viewpoints and persons with varying areas of expertise. Participant materials will be prepared for use during the workshops. A compilation of pertinent articles and reference materials will also be available for participants. Together, the training and supporting materials will enhance the key principles of Mn/DOT's present project development process and integrate certain elements of various other initiatives including project management, environmental education, public involvement and flexibility in the highway design process.

Conclusions:
A 3-ring binder was created.

Implementation:
N/A

Implementation Outcome:
N/A

No Deliverable

Principal Investigator:
Cheri Marti, CTS, University of Minnesota

Technical Liaison:
Julie Skallman, Mn/DOT, State Aid for Local Transportation Division

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 119

Contract Period:
April 22, 2004 to December 30, 2005

Funding:
$140,000 STIP
$244,000 LRRB

Program:
CY 2004 LRRB INV 668 and Mn/DOT Transportation Research Program

2004 Minnesota Technology Transfer (T2) LTAP Program

Description:
To provide funding for the 2004 LTAP/LRRB Technology Transfer Program managed by the Center for Transportation Studies, University of Minnesota.

Conclusions:
N/A

Implementation:
N/A

Implementation Outcome:
N/A

No Deliverable

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Technical Liaison:
Shongtai Dai, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 114

Contract Period:
February 27, 2004 to December 30, 2005

Funding:
$53,000 Pooled Fund
$102,000 LRRB

Program:
CY 2005 LRRB INV 816 and Pooled Fund

Low Temperature Cracking of Flexible Pavement Due to Thermal Fatigue and Combined Effects Temp/Load

Description:
The new equipment will allow performing advanced laboratory characterization of asphalt materials used in pavements to better understand the role played by the mixture components, the mix design and the mixture preparation with respect to the material resistance to low temperature cracking.

Conclusions:
An instrumented triaxial cell was purchased jointly from MTS Systems Corporation and Research Engineering, Inc. This cell will complement the existing MTS test frame used to characterize the mechanical properties of asphalt mixtures under a variety of loading conditions. Also purchased from MTS was another set of vertical extensometers used primarily for dynamic modulus testing of asphalt mixtures. These combined purchases represent almost half of the price quoted for a complete instrumented triaxial cell from other companies.

The University of Minnesota also purchased a device made in their machine shop for testing the fracture properties of asphalt binders at low temperatures.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

No Deliverable

Principal Investigator:
Robert Johns, CTS, University of Minnesota

Technical Liaison:
Loren Hill, Mn/DOT, Formerly Office of Traffic, Security and Operations

Administrative Liaison:
N/A

Contract:
81655 WO 90

Contract Period:
3/29/2004 to 3/31/2005

Funding:
$40,553.26 Consultant Services
$70,507.23 Towards Zero Deaths
$8,939.51 Towards Zero Deaths Committee

Program:
ITS

Towards Zero Deaths (TZD) Program Administration and Outreach (NON RSS)

Description:
The objective of this project is to continue providing administrative support and coordination to the TZD Program Team. In addition, CTS will provide outreach and communications support for the program and the team. workshop or conference; coordinate meetings and workshops with new TZD community coalitions; and coordinate market research activities for the TZD Program.

Conclusions:
N/A

Implementation:
N/A

Implementation Outcome:
N/A

DVD TE233

Principal Investigator:
Jim Grothaus, CTS, University of Minnesota

Technical Liaison:
Richard West, Otter Tail County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 80

Contract Period:
1/2/2004 to 12/30/2005

Funding:
$77,000 State Aid

Program:
Pavement

Gravel Road Maintenance - Meeting the Challenge

Description:
To develop a training video and instructional guide and provide training in performing basic motor grader and gravel road maintenance techniques to staff responsible for these activities.

Conclusions:
The primary objective of this DVD is to show maintenance workers, supervisors, and engineers the right way to perform gravel road maintenance. The secondary objective is to show the public what can be done, what is being done, and why it needs to be done. The DVD was designed to be used as a training tool in conjunction with the Federal Highway Administration's manual, Gravel Roads Maintenance and Design Manual. The DVD is designed to be used primarily to introduce topics in live training sessions for road maintenance workers. It will be the responsibility of the trainer to explain the details of how to accomplish the various tasks. This DVD can either be used as a stand-alone tutorial or as an instructor's tool to introduce the topics of gravel road maintenance. Each chapter of the DVD discusses a specific maintenance topic. After playing a chapter, the instructor can pause the DVD and use other materials to teach the class.

Implementation:
The Minnesota Local Technical Assistance Program has this video listed on their web site.

No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

To request a copy of the complete DVD and instructional documents:
http://www.mnltap.umn.edu/resources/videos/GravelRoadMaintenance/

No Deliverable

Principal Investigator:
Jeffrey Buxbaum, Cambridge Systematics

Technical Liaison:
Kenneth Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
83110

Contract Period:
11/1/2002 to 4/30/2006

Funding:
$731,552.92 Pooled Fund
$218,471.07 Mileage-Based User Fee Demo

Program:
Pooled Fund and Office of Investment Management

Mileage Based User Fees Demonstration

Description:
To develop and conduct a demonstration project that will test price elasticities of driving behavior by offering financial incentives and/or by simulating the replacement of fixed costs of ownership/leasing and operation with fees or charges based on mileage or time-of-day travel.

Conclusions:
None noted

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

No Deliverable

Principal Investigator:
Cathy French and Carol Shield, University of Minnesota

Technical Liaison:
Erik Wolhowe and Keith Molnau, Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract:
86155 WO 187

Contract Period:
9/1/2005 to 12/30/2005

Funding:
$53,844 Pooled Fund
$13,461.50 Bridge

Program:
SPR 0005(300)

Instrumentation of a Full Depth Precast Concrete Bridge Deck System—SPR 0005(300)

Description:
The purpose of this project is to instrument a precast concrete bridge developed for rapid replacement/construction. Data collection and analysis will be done as part of a separate project.

Conclusions:
A chapter will be inserted in the final report for "Monitoring and Analysis of a Full Depth Precast Concrete Bridge Deck System" Contract 81655 WO 171.

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

Related Projects:
"Monitoring and Analysis of a Full Depth Precast Concrete Bridge Deck System" Contract 81655 WO 171

“Application of Precast Decks and Other Elements to Bridge Structures” Contract 81655 WO 146

No Deliverable

Principal Investigator:
Laurie McGinnis, CTS, University of Minnesota

CoPrincipal Investigator:
Gina Baas, CTS, University of Minnesota

Technical Liaison:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Sandy McCully, Mn/DOT

Contract:
81655 WO 111

Contract Period:
2/2/2004 to 2/28/2006

Funding:
$100,000 Research Administration
$57,800 LRRB

Program:
LRRB

Research Publication and Outreach Services

Description:
To provide assistance to Mn/DOT's Research Services Section in the areas of publishing and dissemination of research results and the administration of the research contracting process.

Conclusions:
N/A

Implementation:
No Implementation Plan was written.

Implementation Outcome:
No Close-out memo was written.

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Contract 88502

Principal Investigator:
Brock McMillan, Mankato State University

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Period:
8/15/2005 to 6/30/2008
Funding:
$99,132 STIP

Wildlife Value of Reed Canary Grass Infested Wetlands in Minnesota

Description:
The purpose of this project is to compare the wildlife value of wet meadows that have been invaded by reed canary grass to wet meadows that are comprised of native wetland vegetation.

Status: Work in progress

Contract 88277

Principal Investigator:
Kenneth Miller, State Cloud State University

Technical Liaison:
George Cepress, Mn/DOT, Office of Transportation Data & Analysis

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
8/1/2005 to 8/31/2006

Funding:
$37,068 STIP

Feasibility Study of Portable Weigh-in-Motion (WIM) Systems for Highway Speed

Description:
The purpose of this project is the provide specifications for portable weigh-in-motion systems and identify acceptable suppliers. The projects will study WIM information in 3 areas, studies in other states, update on previous work and visiting existing WIM portable WIM systems. The required systems must be capable of monitoring traffic at highway speeds with little or no permanent modification to the road. At the end of this project, Mn/DOT will have a set of purchasing specifications and test data on candidate systems.

Status: Work in progress

Contract 88200

Principal Investigator:
Magdy Abdelrahman, North Dakota State University

Technical Liaisons:
Tim Andersen, Mn/DOT, Office of Materials and Milton Alm, Norman County

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
6/29/2005 to 7/31/2007

Funding:
$40,828 STIP
$40,828 LRRB
INV 831

Investigation of Stripping in MN Class7 (RAP) and Full Depth Reclamation Base Material

Description:
This research will assess the changes in the asphalt content and properties of RAP as used in base materials in Minnesota. This will help characterizing the effectiveness of RAP as a structural component in base layers. The research will also test if potential contamination to ground water is likely to occur as a result of using RAP in base materials.

Status: Work in progress

Active Projects

Contract 88193

Principal Investigator:
James Wilde, Mankato State University

Technical Liaisons:
Tom Wood, Mn/DOT, Office of Materials & Alan Forsberg, Blue Earth County

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
6/17/2005 to 5/31/2007

Funding:
$60,080 LRRB
INV 836

Design Procedures for Bituminous Stabilized Road Surfaces for Low Volume Roads

Description:
Many roadways in the city and county road systems in Minnesota consist of unpaved aggregate surfaces. In order to upgrade these roads to improve safety, reduce maintenance cost and improve the surface of the roadway is to create a bituminous stabilized layer of aggregate in the top several inches of an aggregate surfaced roadway using mix-in-place methods. The County Engineers responsible for the pavement designs, however, need a design method to provide county engineers and their staff with the technical backing needed for the designs selected. Mn/DOT had developed several versions of a low-volume road design guide. This guide does not address the construction methods used to upgrade these aggregate surfaced roads in the way these counties would like to use them. Other agencies have conducted similar studies and these are outlined in the literature review portion of this work plan.

Status: Work in progress

Contract 88174

Principal Investigator:
Amiy Varma, North Dakota State University

Technical Liaison:
Brian Gage, Mn/DOT, Office of Investment Management

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
6/27/2005 to 11/30/2006

Funding:
$40,000 STIP
$15,000 LRRB
INV 832

Volume Warrants for Right Turn Lanes

Description:
Analyze geometric, speed, volume and crash data for a broad range of conditions related to right turn lanes in Minnesota. Develop procedures for establishing and applying volume warrants for right turns by Mn/DOT on highways.

Status: Work in progress

Contract 88173

Principal Investigator:
Amiy Varma, North Dakota State University

Technical Liaison:
Robert Gale, Mn/DOT, Office of Freight and Commercial Vehicle Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
6/27/2005 to 11/30/2006

Funding:
$69,000 STIP

Development of Measurement Sources for Freight Performance Indicators

Description:
Freight is playing an increasingly important role in transportation planning, service and investments at local, state, regional, national and international levels. Minnesota DOT has been involved with several studies dealing with Freight Performance Measures, Upper Midwest Freight Corridor, Freight Facilities and Freight flows in and out of Minnesota and others. Minnesota has developed reports on freight analysis frameworks. At a federal level freight capacity and bottlenecks have studied by TRB and FHWA. Freight data needs have been identified by many and there are numerous data as well as modeling challenges facing professional community, agencies, shippers and carriers as we see our freight movement getting increasingly interdependent on various infrasturcture, operational and logistic systems. Minnesota is concerned with freight data issues and needs to determine what are the appropriate data to use, what new data to develop and what will be the costs and benefits of developing and maintaining a data program to address the freight performance goals.

Status: Work in progress

Active Projects

Contract 88127

Principal Investigator:
Magdy Abdelrahman, North Dakota State University

Technical Liaisons:
Mike Leegard, Mn/DOT, Office of Land Management

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
6/29/2005 to 6/29/2007

Funding:
$88,244 STIP

Best Value Based on Performance

Description:
The proposed project will develop a system that is driven by the "best value based on performance" concept to evaluate the current contracting procedures by the State of MN. The proposed system will collect and evaluate relevant data on construction projects and contractor qualifications. The study will develop recommendations to improve current specifications and bid offering, if necessary, based on the analysis of available records. The proposed research will compare the use of different bid selection criteria such as quality of work including material production, completion dates, safety and traffic control and compliance with environmental requirements, labor requirements; Disadvantage Business Enterprise (DBE) and Equal Employment Opportunity (EEO). This study will address issues related to the pre-qualification mechanism and the contractor rating systems of Mn/DOT.

Status: Work in progress

Contract 87871

Principal Investigator:
Michael Marti, SRF Consulting Group

Technical Liaisons:
Marcus Hall, St. Louis County

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
9/7/2005 to 9/30/2008

Funding:
$46,035.23 LRRB
INV 999

LRRB Outreach/Communication Activities

Description:
Utilizing existing networks, resources and strategies, develop communication and outreach activities that will increase awareness of LRRB research and implementation activities. The information that is developed must be concise, meaningful and easily accessed by local engineers and those who work with local government engineers.

Status: Work in progress

Contract 87859

Principal Investigator:
Dean Deeter, Castle Rock Consultants

Technical Liaisons:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Nelson Crux, Mn/DOT

Contract Period:
8/24/2005 to 7/30/2007

Funding:
$19,917.5 Investment Management
$19,917.50 LRRB

LRRB-RSS Web Site Hosting and Maintenance 2006 - 2007

Description:
To provide hosting and maintenance services for the LRRB and RSS web sites.

Status: Work in progress

Active Projects

Contract 87789

Principal Investigator:
Ginny Crowson, Short Elliot Hendrickson, Incorporated

Technical Liaisons:
Mark Nelson, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
10/14/2005 to 7/31/2007

Funding:
$36,286.53 NW Passage Pooled Fund
$71,929.39 Pooled Fund

North/West Passage Transportation Pooled Fund Study - Phase II—(TPF-5(093)

Description:
The purpose of this project is to develop an expanded ITS integrated Corridor Strategic Plan for the North/West Passage Corridor. Development of the ITS plan will help the state to coordinate integrated corridor efforts particularly across state borders and identify future projects to pursue within the North/West Passage Corridor. The plan will include a high level architecture for the corridor, an inventory of communication coverage and a coordinated deployment/concept of operations for traveler information.

Status: Work in progress

Program: 2006 SP&R Program

Contract 87369

Principal Investigator:
SRF Consulting, Inc.

Technical Liaisons:
Mark Maloney, City of Shoreview

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
3/18/2005 to 2/28/2007

Funding:
$219,958 LRRB
For SRF and Tasks 1-7 only
INV 645

Implementation of Research Findings (2005-2006)

Description:
To develop and conduct transportation research implementation activities that bring research findings and current technologies to local county and city governments in a manner that facilitates application at the local level.

Status: Work in progress

Contract 87119

Principal Investigator:
Meridian Environmental Technology, Inc.

Technical Liaisons:
Curt Pape, Mn/DOT, Office of Maintenance

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
11/4/2004 to 4/30/2006

Funding:
$25,000 Pooled Fund

Development of Interactive Statewide Web-based Monitoring System (Aurora)

Description:
Develop an interactive, web-based administrative solution to communicate the condition of a statewide RWIS system with four levels of authority--view only, limited update, update, and administrator.

Status: Work in progress

Active Projects

Contract 86661

Principal Investigator:
Axiom Decision Systems, Incorporated

Technical Liaison:
Shongtao Dai, Mn/DOT, Office of Materials

Contract Period:
8/12/2004 to 6/30/2006

Funding:
$32,954.35 Pooled Fund

Implementation of Resilient Modulus Startup and Quality Control Procedure

Description:
The objective of this work is to verify the ability of State's Office of Materials and Road Research laboratory equipment to perform modulus testing. State will provide personnel, equipment and materials to perform the Federal Highway Administration (FHWA) Long Term Pavement Performance (LTPP) Resilient Modulus of Unbound Materials Laboratory Startup and Quality Control Procedure as referenced in Publication No FHWA-RD-96-176 (January 1997) and as amended by the project team for use in the LTPP Program. Contractor will provide an analysis of the data and a summary of the recommendations concerning the results of the implementation effort.

Status: Work in progress

Contract 86536

Principal Investigator:
Tuncer Edil, University of Wisconsin - Madison

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
5/28/2004 to 10/31/2006

Funding:
$63,715 COPTRS
$149,280 LRRB
INV 810

Demonstration of Ash Utilization in Low Volume Roads

Description:
Propose that LRRB and Mn/DOT consider a state-wide vision to establish coal ash stabilization as a common technique for road construction.

Status: Work in progress

Contract 86100

Principal Investigator:
David Noyce, University of Wisconsin - Madison

Technical Liaison:
Tom Foley, City of Richfield

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
5/5/2004 to 6/30/2006

Funding:
$25,728 STIP
$25,728 LRRB
INV 791

Safety & Operational Characteristics of Two-Way Left Turn Lanes

Description:
This research will compare crash rates and operational characteristics, using before and after procedures, to determine if roadways constructed with TWLTLs are safer or operationally more efficient compared to four-lane divided or four-lane undivided roadways. A detailed review of experiences in other states will also be presented including factors related to capacity, limitations on their applicability, operating speeds, access control and accommodation of non-motorized roadway users.

Status: Work in progress

Active Projects

Contract 82647

Principal Investigator:
Tom Schnell, University of Iowa

Technical Liaison:
Glen Ellis, Mn/DOT, State Design Engineer

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Period:
11/22/2004 to 3/31/2007

Funding:
$131,667 STIP

Turn Lane Lengths for Various Speed Roads and Evaluation of Determining Criteria

Description:
Provide Mn/DOT with clear and user-friendly design guidelines to determine the optimum length of turn lanes at intersections from a systems design point of view.

Status: Work in progress

Contract 82617 WO 8

Principal Investigator:
Tom Maze, Iowa State University

Technical Liaison:
Steve Haider, Mn/DOT, Office of Maintenance

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract Period:
10/1/2005 to 10/30/2006

Funding:
$82,035 STIP

Snow and Ice Operations Cost Analysis

Description:
The objective of this project is to conduct an independent evaluation of Mn/DOT winter maintenance performance indicators and LEM data collection and processing practices. The evaluation will seek to establish whether the correct data elements are being collected and to see if the appropriate analysis is being conducted on the available data.

Status: Work in progress

Contract 82617 WO 4

Principal Investigator:
Shauna Hallmark, Iowa State University

Technical Liaison:
Roger Gustafson, Carver County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
7/1/2003 to 9/30/2006

Funding:
$51,180 LRRB
INV 805

Safety Impacts of Street Lighting at Isolated Rural Intersections - Phase II

Description:
To analyze and quantify the effectiveness of rural lighting in reducing nighttime crashes at isolated, rural intersections, provide recommendations for new lighting installations, and refine the recommended warrants/guidelines from a previous LRRB study.

Status: Work in progress

Active Projects

Contract 81655 WO 207

Principal Investigator:
Cheri Marti, University of Minnesota

Technical Liaison:
Peter Buchen, Mn/DOT, Office of Aeronautics

Administrative Liaison:
None

Contract Period:
1/1/2006 to 1/31/2008

Funding:
$67,500 Aeronautics-Construction Grants Stat

06-07 AirTAP Work Plan

Description:
The purpose of this research will lead to increased knowledge by airport professionals in both the public and private sectors of new technology and techniques for designing, maintaining, operating and administering small airports thereby improving service delivery. The program will also strengthen inter-agency dialogue, thereby encouraging the expansion of mutually beneficial partnerships. Overall this will result in an improved public image of local agencies and airport operation, which have a positive impact on the community. Benefits of this educational and outreach program can be measured through feedback from participants, the increase in partnerships among affected parties and, ultimately, the quality of the improved operational safety of the airport system.

Status: This is not a Research Project - no AL/TL Assigned - use of Work order number only

Contract 86155 WO 203

Principal Investigator:
Janet Creaser, University of Minnesota

Technical Liaison:
Loren Hill, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
10/26/2005 to 2/28/2007

Funding:
$50,000 Public Safety
$36,130 STIP

Evaluation of Minnesota's Operation NightCAP

Description:
The objective of this project is to evaluate the effectiveness of the Operation NightCAP Program and its potential influence on DWI arrests and alcohol-related crashes, and on the public's perception of DWI enforcement in Minnesota. The research will survey a sample of enforcement officers involved in NightCAP to identify any positive initiatives or constraints in the process of conducting Operation NightCAP saturation patrols

Status: Work in progress

Contract 86155 WO 201

Principal Investigator:
Gina Baas, University of Minnesota

Technical Liaison:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
12/3/2005 to 11/30/2006

Funding:
$18,100 COPTRS

Access Study Administration and Outreach

Description:
The objectives of this project are to: 1) provide ongoing administrative and managerial oversight necessary to coordinate the research efforts of the Access to Destinations Study and 2) provide the development of and the maintenance for a web site for the study and two event related activities.

Status: Work in progress

Program: Ongoing Access to Destinations

Active Projects

Contract 86155 WO 200

Principal Investigator:
Thomas Stinson, University of Minnesota

Technical Liaison:
Julie Skallman, Mn/DOT, State Aid

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
11/15/2005 to 11/30/2006

Funding:
$64,000 LRRB

Local Road Funding History

Description:
The purpose of this project is to study and examine Minnesota local road funding between 1996 and 2003 and provide a detailed summary of local road revenues and expenditures for counties, and cities. This will better inform the policy debate by answering questions.

Status: Work in progress

Contract 86155 WO 199

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
None

Administrative Liaison:
None

Contract Period:
10/18/2005 to 3/31/2007

Funding:
$53,000 Consultant Service
$25,000 Traffic Engineering

Evaluating the Effectiveness of the Minnesota Speed Management Program

Description:
The objective of this project is to assess the effectiveness of the MSMP with regard to the following: Reducing traffic speed; Reducing the number of fatal and type "A" injury crashes; Improving drivers awareness of speed and their relationship to traffic safety; Improving safety on roadways. A separate survey of drivers addressing driver awareness issues will be performed by MarketLine Research. Their findings will synthesized with the objective driver behavior data yielded from this research project.

Status: No AL or TL needed on this contract

Contract 86155 WO 197

Principal Investigator:
Max Donath, University of Minnesota

Technical Liaison:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
10/21/2005 to 10/31/2006

Funding:
$200,000 STIP

ITS Institute Mn/DOT Match - FY06

Description:
Contract for RSPA (US DOT) fund transfer - ISTEA21 Match

Status: Work in progress

Active Projects

Contract 86155 WO 196

Principal Investigator:
Gina Baas, University of Minnesota

Technical Liaison:
Barb Bauer, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Barb Bauer, Mn/DOT

Contract Period:
10/7/2005 to 6/30/2006

Funding:
$20,000 Environmental Services Consulting

2006 Environmental Stewardship and Streamlining Workshop

Description:
The objective of this project is to plan and organize a workshop that will provide the latest information and best practices for environmental stewardship and streamlining to Mn/DOT staff and their partners, such as resource and regulatory agencies local units of government, and consulting firms. The topics to be covered will include, regulations, new legislation, document preparation, methodologies related to key environmental issues, waste management, pollution prevention and maintenance issues.

Status: Work in progress

Contract 86155 WO 188

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaisons:
Jim Grube, Hennepin County
and
Gene Hicks, Mn/DOT, Transportation Planning

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
9/10/2005 to 1/31/2007

Funding:
$54,984 Metropolitan Council

Access to Destinations: Estimation of Arterial Travel Times

Description:
The objective of this project is to develop, test and recommend methods for network wide estimation and prediction of travel time on arterials. The expectation is that the recommended method will produce plausible default estimates when given predicted demand flows and will update these default estimates where and when field measurements are available.

Status: Work in progress

Contract 86155 WO 186

Principal Investigator:
Andrew Drescher, University of Minnesota

Technical Liaison:
Tim Andersen, Mn/DOT, Office of Materials & Richard Heilman, Isanti County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
9/1/2005 to 2/28/2008

Funding:
$110,000 LRRB
INV 824

Development of Improved Proof Rolling Methods for Roadway Embankment Construction

Description:
Phase I will determine the best approach and parameters required to model analytically and/or numerically the problem of a test roller on a compacted roadway subgrade. Phase II of the project will concentrate on comparing the analytic/numerical results with results of selected physical rolling tests. The possible differences will be analyzed and incorporated in recommendations with potential direct impact on embankment construction practices.

Status: Work in progress

Active Projects

Contract 86155 WO 185

Principal Investigator:
Robert Johns, University of Minnesota

Technical Liaison:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
7/1/2005 to 7/31/2007

Funding:
$1,600,000 STIP

FY06-07 CTS Operations

Description:
This project provides base funding for the Center for Transportation Studies for fiscal years 2006-2007.

Status: Work in progress

Contract 86155 WO 183

Principal Investigator:
Gina Baas, University

Technical Liaison:
None

Administrative Liaison:
None

Contract Period:
8/15/2005 to 4/28/2006

Funding:
$70,000 Towards Zero Deaths

2005 Toward Zero Deaths Conference

Description:
The purpose of this project is to integrate and connect the agenda of transportation safety stakeholders in Minnesota by providing an opportunity to learn about the latest local and state and national information regarding traffic safety. Provide training and certification for Safe & Sober and Child Passenger Safety grant recipients in their area of specialty while also offering them opportunities to learn from the general session presentations.

Status: This is not an RSS project; it is the Office of Traffic, Security and Operations.

Contract 86155 WO 182

Principal Investigator:
John Nieber, University of Minnesota

Technical Liaison:
Ruth Roberson, Mn/DOT, Office of Materials & Stephen Schnieder, Nobles County

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Period:
8/1/2005 to 4/30/2008

Funding:
$186,735 LRRB
INV 830

Evaluating Roadway Subsurface Drainage Practices

Description:
The purpose of this project is the evaluate the difference in drainage efficacy of edge-drains compared to centerline drains for low volume roads, paved or unpaved. Evaluate the benefits of subsurface drainage and determine the benefits of draining only low points in the road profile. Evaluate the effect of increased amount of crushed concrete in aggregate base and shoulder on drain performance with respect to possible plugging by concrete constituents. Evaluate an electromagnetic inductance method for non-invasively measuring soil moisture within roadway base and sub-grade materials. Use statistical analysis and flow models to develop drainage design standards.

Status: Work in progress

Active Projects

Contract 86155 WO 180

Principal Investigator:
Taek Kwon, University of Minnesota—Duluth

Technical Liaison:
George Cepress, Mn/DOT, Office of Transportation Data & Analysis

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
9/6/2005 to 10/31/2007

Funding:
$89,612 STIP

Development of Portable Eight-Channel WIM Analysis System Based on Analog WIM Signals

Description:
The objective of this project is to develop and deliver an analog 8-channel WIM analysis and data collection system that can directly probe and analyze the analog WIM signals. The system will have 2 operational probes. The first is a probe mode in which WIM sensor signals are carefully sampled and analyzed, the second mode of operation is a WIM data collection mode where the system directly converts and computes the WIM signals to a standard WIM data format and then the data is saved which can be accessed for database analysis or load spectra computation. The developed system will be completely designed and implemented only using off the shelf products so that Mn/DOT can easily reproduce the system in-house in the future.

Status: Work in progress

Contract 86155 WO 179

Principal Investigator:
Francis Harvey and Kevin Krizek, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
8/5/2005 to 12/31/2006

Funding:
$69,618 STIP

Commuter Bicyclist Behavior and Facility Disruption

Description:
The purpose of this research is to determine (1) what disruptive factors affect route choices among bicycle commuters. (2) In what manner do bicyclists make route choice decisions when faced with disruptions. (3) in what manner do the behaviors of commuting bicyclists correspond to results from previous travel behavior research for automobile drivers.

Status: Work in progress

Contract 86155 WO 176

Principal Investigator:
Panos Michalopoulos, University

Technical Liaison:
Todd Kramascz, Mn/DOT, Office of Traffic, Security, and Operations

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Period:
11/7/2005 to 4/30/2007

Funding:
$75,000 ITS Project Match

Employment of the Traffic Management Lab for the Evaluation and Improvement of Stratified Metering Algorithm: Phase III

Description:
This project is a continuation of the project related to testing and evaluating the effectiveness of the Stratified Ramp Metering strategy through rigorous microscopic simulation. The Stratified Ramp Metering strategy has been proved to be generally effective in keeping the wait time below the maximum allowed for each ramp after one-year field operation and a preliminary evaluation. Yet some inherent limitations of the strategy need to be further explored. This research project aims at attacking these limitations by developing a credible, efficient and feasible methodology which can balance the control objectives of the freeway performance and the ramp delays and provide more accurate on-line ramp queue size estimation. All the enhancements and improvements to the Stratified Ramp Control strategy will be computationally feasible and their effectiveness will be assessed by comparison with the current prototype version using microscopic simulation.

Status: Work in progress

Active Projects

Contract 86155 WO 175

Principal Investigator:
Lev Khazanovich, University of Minnesota

Technical Liaison:
Dave Johnson, Mn/DOT, Office of Materials

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
6/20/2005 to 11/30/2006

Funding:
$57,500 COPTRS

MnROAD Lessons Learned - Synthesis

Description:
The purpose of this research will formally review 1) MnROAD's accomplishments thus far; 2) how MnROAD has contributed to research in pavements and 3) the indirect effects of MnROAD on the pavement community in general. To accomplish this review, the research will survey and summarize significant research at MnROAD while accounting for other less-known or unaccounted for research incorporating MnROAD data. The research will also assess MnROAD's operations over the past decade relative to its initial research objectives and will briefly propose future objectives as the MnROAD facility moves into its second decade of operation.

Status: Work in progress

Contract 86155 WO 171

Principal Investigator:
Cathy French, University of Minnesota
CoPrincipal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
Keith Molnau, Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
8/3/2005 to 9/30/2008

Funding:
$190,477 STIP

Monitoring and Analysis of a Full Depth Precast Concrete Bridge Deck System

Description:
The purpose of this project is to monitor and evaluate the behavior of a precast concrete bridge developed for rapid replacement/ construction. Data collected will be evaluated for performance of the bridge and its components, using instrumentation that was installed as part of the construction project. Portions of similar deck components cast at the time of the bridge construction will be monitored and tested within the laboratory environment. This will provide a better understanding of the performance of the system in order to develop better design guidelines and standard details.

Status: Work in progress

Contract 86155 WO 170

Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Jim Pierce, Mn/DOT, Office of Bridges

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
8/1/2005 to 11/30/2006

Funding:
$55,000 STIP

Evaluation and Analysis of Mn/DOT Steel Bridges Inventory for Prioritizing Bridge Maintenance Needs

Description:
The purpose of research is to assess fatigue problems in steel bridges and estimating their remaining life, including those related to 1) assessing distortional fatigue, 2) load rating for increased truck weights and 3) other problematic details such as cover plates terminated in tension flanges, will be used for defining the criteria for bridge evaluation and ranking. A bridge analysis and rating scheme will be developed on the basis of these recommendations within Mn/DOT bridge management framework.

Status: Work in progress

Active Projects

Contract 86155 WO 169

Principal Investigator:
Diwakar Gupta, University of Minnesota

Technical Liaison:
Michelle Gutzmann, Mn/DOT, Office of Transit

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
8/1/2005 to 7/31/2007

Funding:
$55,000 COPTRS

Improving Capacity Planning for Demand-Responsive Para transit Services

Description:
This project will address operational issues related to the mobility of ADA passengers who use public paratransit services. The research will be driven by current needs in the Twin Cities area, but techniques developed here will also apply to other Minnesota cities and counties serving ADA populations.

Status: Work in progress

Contract 86155 WO 166

Principal Investigator:
Kevin Krizek, University of Minnesota

CoPrincipal Investigator:
Ahmed El-Geneidy, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
06/15/2005 to 03/30/2007

Funding:
$44,750 COPTRS
Co-sponsored with Hennepin County

Refining Methods for Calculation Non-Auto Travel Times

Description:
The purpose of this research is to generate and refine methodologies for calculating non-auto (transit, bicycle, walking) travel times between origins and destinations within the Twin Cities. When married with detailed measures of land use activity, these derived travel times can be used as required input parameters to calculate the accessibility to destinations within the metropolitan area using differing modes of transportation.

Status: Work in progress

Program: 2005 Access to Destinations Program

Contract 86155 WO 163

Principal Investigator:
Joseph Labuz, Randal Barnes, Bojan Guzina
University of Minnesota

Technical Liaison:
Dave Shanahan, Wabasha County
Jeff Gebhard, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
11/15/2005 to 8/31/2007

Funding:
$55,000
INV 835

Best Use of Cone Penetration Testing

Description:
The goal of this project is to determine a relationship between resilient modulus and cone penetration testing (CPT). The study will result in recommendations to Mn/DOT on the possible use of CPT in pavement design.

Status: Work in progress

Active Projects

Contract 86155 WO 162

Principal Investigator:
John Gulliver, University of Minnesota
CoPrincipal Investigator:
Omid Mohseni, University of Minnesota

Technical Liaison:
Jon Haukaas, Mn/DOT, City of Fridley

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
6/1/2005 to 9/30/2007

Funding:
$138,000 LRRB
Inv 834

Assessment of Storm Water Management Practices on the Water Quality of Runoff

Description:
The results of this study will help cities, counties and other agencies to make informed decisions regarding the purchase and installation of underground stormwater treatment structures which are required to meet the MPCA's NPDES regulations.

Status: Work in progress

Contract 86155 WO 161

Principal Investigator:
Bruce Wilson, University of Minnesota

Technical Liaison:
Brett Troyer, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
12/1/2005 to 4/30/2008

Funding:
$43,500 STIP
$45,500 LRRB
INV 833

Design Tool for Controlling Runoff and Sediment from Highway Construction

Description:
Develop a tool for the design of effective sediment control strategies for construction sites. Expand upon current modeling efforts to include off-site sediment control practices. Expand upon current modeling efforts to incorporate processes at a watershed scale by linking together the responses of different land uses. Develop user friendly interface routines that allow spatial data sets to be integrated into the model.

Status: Work in progress

Contract 86155 WO 160

Principal Investigator:
Laurie McGinnis, CTS, University of Minnesota

Technical Liaison:
Clark Moe, Mn/DOT, Office of Investment Management

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
5/6/2005 to 2/28/2007

Funding:
$44,021 COPTRS

Implementation and Closeout of FY 04 Research Projects

Description:
To develop research implementation plans and/or closeout memos based on Mn/DOT and Local Road Research Board research findings for projects completed in F.Y. 04.

Status: Work in progress

Active Projects

Contract 86155 WO 159

Principal Investigator:
Gina Baas, CTS, University of Minnesota

Technical Liaison:
Scott Bradley, Mn/DOT, Office of Technical Support

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
4/8/2005 to 7/31/2006

Funding:
$48,676 Consultant Services
$25,000 Engineering Services
$25,000 Transportation Research (TRCA)

2005 Midwest Regional Context Sensitive Design and Solutions Workshop

Description:
Plan and organize a regional workshop that will address tough questions and challenges from around the country as well as lessons being learned and innovation being pursed to further excellence in transportation project development using CSDS philosophy and principles.

Status: Work in progress

Contract 81655 WO 157

Principal Investigator:
Jim Grothaus, University of Minnesota

Technical Liaison:
Richard Larson, Mille Lacs County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
3/24/2005 to 10/31/2006

Funding:
$36,521 LRRB

INV 998: 2004/2005 Operational Research Program for Local Transportation Groups

Description:
The ongoing management needs of the LRRB Applied Research for Local Transportation Program include both program management and research project-management services. Program management includes overall program implementation, policy recommendations, program record keeping, financial management, and annual reporting to the LRRB. Research project-management includes research project solicitation, project development, application assistance, agreement execution, project oversight, final report editing, and project payments.

Status: Work in progress

Contract 81655 WO 156

Principal Investigator:
Joseph Labuz, University of Minnesota

Technical Liaison:
Shongtao Dai, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
3/18/2005 to 6/30/2006

Funding:
$55,000 STIP

Resilient Modulus Dev. Containing Recycled Bituminous and Concrete for 2002 Design Guide and MnPAVE Pavement Design

Description:
To quantify engineering properties, such as resilient modulus and shear strength, of aggregate base/subbase containing recycled bituminous and concrete and shredded tire subgrades.

Status: Work in progress

Active Projects

Contract 81655 WO 153

Principal Investigator:
Cheri Marti, CTS, University of Minnesota
CoPrincipal Investigator:
Jim Grothaus, CTS, University of Minnesota

Technical Liaison:
Julie Skallman, Mn/DOT, State Aid for Local Transportation Division

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
2/1/2005 to 7/31/2006

Funding:
$140,000 STIP
$286,500 LRRB
INV 668

2005 Minnesota Technology Transfer (T2) LTAP Program

Description:
To provide funding for the 2005 LTAP/LRRB Technology Transfer Program managed by the Center for Transportation Studies, University of Minnesota.

Status: Work in progress

Contract 81655 WO 149

Principal Investigator:
Jim Grothaus, CTS, University of Minnesota

Technical Liaison:
N/A

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
12/27/2004 to 8/31/2005

Funding:
$23,300 LRRB

Minnesota Local Agency Safety Pilot Program

Description:
The purpose of this project is to assist local agencies to become more safety-focused organizations that apply the best and most appropriate tools to their safety needs.

Status:
State Aid contract thru Consultant Services Section. Utilizing RSS Work Order number.

Contract 81655 WO 148

Principal Investigator:
Rajesh Rajamani, University of Minnesota

Technical Liaison:
Linda Taylor, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
12/1/2004 to 2/28/2007

Funding:
$140,000 STIP

Automated Winter Road Maintenance Using Road Surface Condition Measurements

Description:
The research objectives of this project are two-fold:
1) To improve the existing vehicle-based tire-road friction measurement system by using additional piezo sensors mounted on the insides of the tires of the snowplow. 2) To automate winter road maintenance using real-time measurements from the friction measurement system and a pavement temperature measurement sensor.
2)

Status: Work in progress

Active Projects

Contract 81655 WO 146

Principal Investigator:
Kathy French, University of Minnesota

Technical Liaison:
Keith Molnau, Mn/DOT, Office of Bridge

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
11/8/2004 to 5/31/2006

Funding:
$55,500 STIP

Application of Precast Decks and Other Elements to Bridge Structures

Description:
Mn/DOT plans to construct two bridges incorporating precast elements to enable rapid construction. The objective of the current study is to develop an instrumentation plan to enable investigation of the performance of the bridge.

Status: Work in progress

Contract 81655 WO 145

Principal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
Gao Yihong, Mn/DOT, Office of Bridge

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
11/8/2004 to 5/31/2007

Funding:
$149,000 STIP

Determining Shear Capacity of Prestressed Concrete Beams

Description:
The objective of the project is to determine if there is a possible shear deficiency in prestressed bridge girders designed using the pre 1980 design specifications. If it appears deficiencies may exist, a 2nd objective is to develop a process to identify the girders most at risk and a 3rd objective is to determine likely methods of retrofit for these girders.

Status: Work in progress

Contract 81655 WO 144

Principal Investigator:
Laurie McGinnis, CTS, University of Minnesota

Technical Liaison:
Dick Stehr, Mn/DOT, Engineering Services Division

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract Period:
9/30/2004 to 9/30/2005

Funding:
$35,000 Engineering Services

TERRA Board Support

Description:
The objective of this project is to develop and support a working Board and related committees for the TERRA organization. The main goal of this alliance is to bring the public sector, private sector, and scholars together to create more opportunities in the pavement research industry.

Status: Work in progress

Active Projects

Contract 81655 WO 143

Principal Investigator:
Albert Yonas, University of Minnesota

Technical Liaison:
Linda Tyler, Mn/DOT, Office of Maintenance

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
9/24/2004 to 5/31/2007

Funding:
$31,000 Maintenance Research

Improving the Ability of Drivers to Avoid Collision with Snowplows in Fog and Snow

Description:
To optimize the design of vehicles such as snowplows so that drivers who follow them will be able to perceive that they are going to crash into them if they don't slow down. The color of the snowplow, the flashing and arrangement of lighting will be investigated to find what combination of spatial, temporal and chromatic conditions make it easiest for the visual system to detect motion carried information for impending collision.

Status: Work in progress

Contract 81655 WO 142

Principal Investigator:
Taek Kwon, University of Minnesota-Duluth

Technical Liaison:
Roberta Dwyer, Mn/DOT, District 1

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
2/1/2005 to 6/30/2006

Funding:
$7,991.20 Guidestar
$1,997.80 STIP

Integration of RTMS ands SQL to Mn/DOT Next Generation R/WIS - Phase 2

Description:
The objective of this project is to expand the present next generation R/WIS to include traffic detection data such as presence, volume, occupancy and speed using non-intrusive traffic sensors, i.e., Remote Traffic Monitoring Sensor (RTMS). Since the next generation R/WIS is built around one or more Sequential Query language (SQL) database servers, a new traffic database will be designed and integrated with the present R/WIS database.

Status: Draft Final Report received

Related Project: "Integration of RTMS and SQL Server to Mn/DOT Next Generation R/WIS", Contract 81655 WO 142

Contract 81655 WO 141

Principal Investigator:
David Levinson, University of Minnesota

Technical Liaison:
Rabinder Bains, Mn/DOT, Office of Investment Management

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
10/8/2004 to 9/29/2006

Funding:
$88,000 STIP

Beyond "Business as Usual": Ensuring the Network We Want is the Network we Get

Description:
This research will assess the implications of existing and proposed network construction decision rules by comparing the networks across a set of performance measures (including, but not limited, to cost, accessibility, mobility, equity, reliability, and system-wide consumer's surplus measures).

Status: Work in progress

Active Projects

Contract 81655 WO 140

Principal Investigator:
Arturo Schultz, University of Minnesota

Technical Liaison:
Paul Kivisto, Mn/DOT, Office of Bridges

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Period:
8/26/2004 to 11/30/2006

Funding:
$137,500 STIP

Determining Economic Strategies for Repair and Replacement of Low Slump Overlays of Bridge Decks

Description:
This project will begin with an effort to collect information from Mn/DOT concerning past practices associated with overlays. This effort includes retrieval of bridge information for the Mn/DOT bridges that received the overlays. The data will be evaluated relative to the information collected during a literature review and time spent with Mn/DOT staff conducting a select number of deck condition surveys.

Status: Work in progress

Contract 81655 WO 137

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Technical Liaison:
Thomas Wood, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
5/1/2005 to 9/30/2007

Funding:
$113,000 STIP
$93,000 LRRB
INV 817

Determination of Optimum Time for Application of Surface Treatments to Asphalt Concrete Products

Description:
The objective of this work is to provide a better understanding of the mechanism by which surface treatments protect the existing pavement from further aging and deterioration due to traffic and environmental loadings and to reasonably predict the optimum time for the application of these treatments.

Status: Work in progress

Contract 81655 WO 136

Principal Investigator:
Nicholas Ward, University of Minnesota

Technical Liaison:
Mike Wagner, Nicollet County
Richard Larson, Mille Lacs County

Administrative Liaison:
Shirlee Sherkow, Mn/DOT

Contract Period:
7/1/2005 to 11/30/2006

Funding:
$188,804
INV813

Rural and Urban Safety Cultures

Description:
The objective of this project is to understand the psychological factors of rural (and urban) residents that maybe related to the significantly higher crash rate on rural roads compared to urban roads.

Status: Work in progress

Active Projects

Contract 81655 WO 135

Principal Investigator:
Joseph Labuz, University of Minnesota

Technical Liaison:
Brad Wentz, Becker County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
6/15/2005 to 9/28/2007

Funding:
$51,000 LRRB
INV808

Pavement Rehabilitation Selection

Description:
The objective of this project is to develop a best practices manual for the selection of asphalt pavement recycling techniques from the many choices that are available. The project will specifically look at full depth reclamation (FDR), cold in place recycling (CIR) and mill/ overlay (M&O). State and county roads and highway professionals will be used as resources.

Status: Work in progress

Contract 81655 WO 134

Principal Investigator:
Kevin Krizek, University of Minnesota

Technical Liaison:
Darryl Anderson, Mn/DOT, Office of Transit

Administrative Liaison:
Shirlee Sherkow, Mn/DOT

Contract Period:
8/31/2004 to 1/31/2007

Funding:
$69,973 STIP

The Safety of Pedestrian and Bicycle Travel in Minnesota: Inventory, Analysis and Prospectus

Description:
This proposed research aims to advance the state of the knowledge of bicycle and pedestrian safety in Minnesota by analyzing currently available data and suggesting best practices for future planning. It will determine how agencies and municipalities collect crash data and how it is categorized.

Status: Work in progress

Contract 81655 WO 132

Principal Investigator:
Joseph Labuz, University of Minnesota

Technical Liaison:
Shongtao Dai, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
12/1/2004 to 1/30/2007

Funding:
$94,000 LRRB
INV812

Resilient Modulus & Strength of Base Course with Recycled Asphalt Pavements

Description:
The goal of this project is to determine resilient modulus and shear strength for recycled asphalt pavement materials used in combination with other aggregate materials in the production of the base course. The resulting data will be useful in helping Mn/DOT develop specifications for the use of salvaged bituminous mixtures.

Status: Work in progress

Active Projects

Contract 81655 WO 131

Principal Investigator:
Bojan Guzina, University of Minnesota

Technical Liaison:
Marc Loken, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
9/13/2004 to 9/30/2006

Funding:
$96,000 STIP

Pavement Evaluation Using Ground Penetrating Radar

Description:
The goal of this project is to develop efficient and more accurate algorithms for the back-analysis of electromagnetic field measurements performed on paved (and unpaved) roads that would translate GPR images into a more reliable information about the thickness of the AC and aggregate base layers, pavement stripping, and mass density of the AC layer. The latter property may be related to amount of voids in pavements, and moisture content of the aggregate base.

Status: Work in progress

Contract 81655 WO 129

Principal Investigator:
Gary Barnes, University of Minnesota

Technical Liaison:
Mitch Webster, Mn/DOT, Office of Investment

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
7/12/2004 to 1/31/2007

Funding:
$50,000 COPTRS

Implications for Transportation Policy of Recent Large Increases in Commute Durations

Description:
The objective of this project is to understand the large increases in commute times that have taken place in the last 10 years, which would start out with the standard influences such as congestion and land use, including changes in the locations of jobs and housing due to land price differentials and other factors, but would go further by incorporating analysis of such factors as increased awareness of distant job opportunities because of the internet, greater vehicle safety and reliability and constraints created by job specialization.

Status: Work in progress

Contract 81655 WO 128

Principal Investigator:
Mihai Marasteanu, University of Minnesota

Technical Liaison:
Ben Woral, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
8/9/2004 to 4/30/2007

Funding:
$665,000 Pooled Fund

Investigation of Low Temperature Cracking in Asphalt Pavements - Pooled Fund Study (TPF-5(080)

Description:
This comprehensive research effort brings, under the same umbrella, the different experimental protocols and analyses and compares them based on a common set of asphalt materials and on well documented field performance data to determine the best combination of experimental work and analyses to improve the low temperature fracture resistance of asphalt pavements.

Status: Work in progress

Active Projects

Contract 81655 WO 127

Principal Investigator:
Peter Graham, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
8/1/2004 to 1/31/2008
Funding:
$103,375 STIP

Improved Methodologies for the Inoculation of Prairie Legumes in Roadside/Revegetation Settings

Description:
This project will be concerned with the evaluation of three different methods of inoculation aimed at increasing rhizobial numbers supplied for prairie legumes and in monitoring legume establishment and function after inoculation. Our goal will be to identify methods of inoculant and rhizobial strains that allow full prairie establishment and function.

Status: Work in progress

Contract 81655 WO 126

Principal Investigator:
Jonathan Chaplin, University of Minnesota

Technical Liaison:
Dwayne Stenlund, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Cory Johnson, Mn/DOT

Contract Period:
8/2/2004 to 7/31/2006

Funding:
$178,524 STIP

Compaction Remediation for Construction Sites

Description:
The goal of this project is to develop a sub-soiling regimen that will enhance and be compatible with existing erosion control measures. This project is important in minimizing the effect of construction-induced compaction on the urban and rural landscape.

Status: Work in progress

Contract 81655 WO 125

Principal Investigator:
Susan Galatowitsch, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
7/14/2004 to 7/31/2007

Funding:
$98,179 COPTRS

Facilitating native plant community establishment in wetlands following invasive plant removal

Description:
The proposed study will determine the conditions under which cover crops are most likely to succeed; specifically, whether they can be used in mixture or are better used between massed plantings, whether different levels of saturation or flooding changes effectiveness, and whether some wetland natives can tolerate cover crop shade better than others.

Status: Work in progress

Active Projects

Contract 81655 WO 124

Principal Investigator:
John Nieber, University of Minnesota

Technical Liaison:
Tina Markeson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Shirlee Sherkow, Mn/DOT

Contract Period:
7/12/2004 to 6/30/2006

Funding:
$155,614 STIP

Management Practices for Weed Control in Roadway Ditches

Description:
The objectives of this project include:
1) Development of an annotated bibliography of current and previous research on technologies (GPS and GIS, videography) and methods used in the management of noxious weeds in ROW, while preserving native species. 2) Evaluation of the procedures currently developed by Mn/DOT's District 4 staff for surveying and mapping the population of noxious weeds along highways.
3) Development/Adaptation of an algorithm/model for predicting the population dynamics of noxious weeds.
4) Development of a users guide for the use of GPS/GIS databases in the management of weed populations located within roadway ROW.

Status: Work in progress

Contract 81655 WO 121

Principal Investigator:
Lev Khazanovich, University of Minnesota

Technical Liaison:
Dave Van Duesen, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
7/12/2004 to 9/29/2006

Funding:
$165,783 STIP
$126,600 LRRB
INV 815

Calibration of the 2002 AASHTO Pavement Design Guide for MN PCC/HMA Pavements

Description:
To improve design guidelines for Minnesota asphalt and concrete pavement by adapting the latest mechanistic-empirical design procedure and calibrating it for local conditions.

Status: Work in progress

Contract 81655 WO 115

Principal Investigator:
Craig Shankwitz, University of Minnesota

Technical Liaison:
John Tarnowski, Mn/DOT, Office of Maintenance

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
2/17/2004 to 8/31/2006

Funding:
$10,316 Maintenance Research

Quick-Edge: Rapid Underbody Plow Cutting Edge Changing System

Description:
Look at an alternative system to the current bolting process. The new system will be designed with the objective of reducing time and manpower required in the change and decreasing the risk of injury as compared to the current labor intensive bolting process. An alternative system will be analyzed, designed, manufactured, tested, and evaluated.

Status: Draft Final Report received

Active Projects

Contract 81655 WO 113

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
Linda Zemotel, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
2/2/2004 to 12/31/2006

Funding:
$50,100 STIP

Capacity Expansion in the Twin Cities: The roads-transit Balance.

Description:
This project will build on previous work by the researchers (Davis and Sanderson 2001) that solved a network design problem for the Twin Cities, but that work will be extended to include transit and incorporate more standard travel demand model procedures that are used in the Twin Cities.

Status: Work in progress

Contract 81655 WO 106

Principal Investigator:
Max Donath, University of Minnesota

Technical Liaison:
Ray Starr, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
1/2/2004 to 12/31/2008

Funding:
$498,500 Pooled Fund

Toward a Multi-State Consensus on Rural Intersection Decision Support (TPF-5(086)

Description:
Multi-state pooled fund study to gain a national basis for deployment of its Intersection Decision Support (IDS) Project. Plan has 3 facets: 1) a review of state intersection crashes for each participating state, 2) participation in the process to design and refine candidate intersection Driver/Infrastructure Interfaces, and 3) instrumentation of candidate intersections to acquire data regarding the behavior of drivers at rural intersections over a wide geographical base.

Status: Work in progress

Contract 81655 WO 104

Principal Investigator:
Cheri Marti, CTS, University of Minnesota

Technical Liaison:
Peter Buchen, Mn/DOT, Office of Aeronautics

Administrative Liaison:
Jim Aamot, Mn/DOT

Contract Period:
12/15/2003 to 5/31/2006

Funding:
$90,000 Aeronautics Construction Grant
$59,960 Aeronautics Navigational Aids
$50,000 Airport Development & Assistance

2004-2005 Minnesota Airport Technical Assistance Program (AirTAP)

Description:
To increase knowledge of airport professionals in both the public and private sectors of new technology and techniques for designing, maintaining, operating and administering small airports, thereby improving service delivery.

Status: Work in progress

Active Projects

Contract 81655 WO 103

Principal Investigator:
Satish Gupta, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
2/1/2004 to 10/27/2006

Funding:
$195,500 STIP

Pavement Design using Unsaturated Soil Technology

Description:
This study will characterize the unsaturated properties (shear strength, dielectric, resilient modulus, and soil-water characteristic curves) of four soils. The experimental database of four soils, along with pore network model, will be used to provide a theoretical framework to develop models for predicting unsaturated soil mechanical properties. The focus of the study will be to propose techniques for predicting resilient modulus of the tests soils using the soil-water characteristic curve and the shear strength.

Status: Work in progress

Contract 81655 WO 99

Principal Investigator:
Frank Douma, University of Minnesota

Technical Liaison:
Adeel Lari, Mn/DOT

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
4/1/2004 to 11/30/2006

Funding:
$571,720 Guidestar
$142,930 STIP

Developing ITS to Serve Diverse Populations

Description:
To identify gaps between the emerging needs and existing services and to propose ways of using technology to bridge the gap. This will be examined through efforts that will produce both long-term and short-term results.

Status: Work in progress

Contract 81655 WO 92

Principal Investigator:
Donald Wyse, University of Minnesota

Technical Liaison:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Administrative Liaison:
Barb Loida, Mn/DOT

Contract Period:
1/2/2004 to 10/31/2006

Funding:
$110,000 COPTRS

Biological Control of Canada Thistle in Wetland Prairie Restoration

Description:
This project will investigate the effectiveness of a recently discovered native biological control agent Pseudomonas syringae pv. tagetis (PST) for the selective control of Canada thistle in prairie restoration systems. Reductions in mowing and herbicide use will result in less environmental impact, enhanced native plant establishment, and reduced cost of prairie wetland restoration

Status: Work in progress

Active Projects

Contract 81655 WO 88

Principal Investigator:
Paul Bloom, University of Minnesota

Technical Liaison:
Robert Edstrom, Office of Environmental Services

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
10/15/2003 to 7/30/2006

Funding:
$98,000 STIP

Chemical Inventory and Database Development for Recycled Material Substitutes

Description:
To produce chemical data on wastes, non-surface background soils and natural aggregates for use in a hazard assessment due-diligence screening tool. In addition, sampling and laboratory protocols will be developed for site and waste specific analyses.

Status: Draft Final Report received

Contract 81655 WO 87

Principal Investigator:
Robert Johns, CTS, University of Minnesota

Technical Liaison:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
7/1/2003 to 6/30/2006

Funding:
$1,600,000 STIP

CTS 2004-2005 Operations

Description:
Provide funding to CTS as mandated by MS1996, Section 161.53 to create an environment within the University or faculty, students and practitioners from multiple disciplines to collaborate in transportation research and education efforts. To provide leadership and outreach efforts to government officials, private sector representatives, and the public in the application of new knowledge and the implementation of policies, programs, and technology that improve transportation.

Status: Work in progress

Contract 81655 WO 83

Principal Investigator:
John Gulliver, University of Minnesota

Technical Liaison:
Scott Morgan, Mn/DOT, District 7—Mankato

Administrative Liaison:
Cory Johnson, Mn/DOT

Contract Period:
9/2/2003 to 12/1/2006

Funding:
$114,000 STIP

Water Quality Performance of Dry Detention Ponds with Underdrains

Description:
Evaluate the pollutant-removing performance of dry water quality ponds designed, owned and maintained by Mn/DOT.

Status: Work in progress

Active Projects

Contract 81655 WO 82

Principal Investigator:
Carol Shield, University of Minnesota

Technical Liaison:
Erik Wolhowe, Mn/DOT, Office of Bridges

Administrative Liaison:
Dan Warzala, Mn/DOT
Contract Period:
9/2/2003 to 11/30/2007

Funding:
$264,000 STIP

Self Compacting Concrete (SCC) for Prestressed Bridge Girders

Description:
This four-year project will entail initial evaluation of the flowability and constructability of a number of SCC mixes. From these mixes, a few will be chosen for further study by casting a number of prestressed-concrete bridge girders and companion cylinders which will be further observed to investigate their time-dependent behavior.

Status: Work in progress

Contract 81655 WO 77

Principal Investigator:
Laurie McGinnis, CTS, University of Minnesota

Technical Liaison:
Dave Johnson, Mn/DOT, Office of Materials

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract Period:
6/9/2003 to 6/8/2008

Funding:
$300,000 Materials & Research
$430,000 LRRB

INV 792: Pavement Research Institute

Description:
To develop and establish a Pavement Research Institute that will bring together multi-disciplinary, collaborative research teams to tap the full range of Federal funds available to academic programs and state agencies to ensure a strong and continuous pavement research effort and ultimately become a self-sustaining program.

Status: Work in progress

Contract 81655 WO 71

Principal Investigator:
Kathleen Harder, University of Minnesota

Technical Liaison:
Brad Wentz, Becker County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
4/15/2003 to 5/31/2006

Funding:
$149,659 LRRB
INV 784

Guidelines for Using Rumble Strips

Description:
Establish restrictive guidelines that will facilitate standardized rumble strip usage in Minnesota. A multi-staged approach will be used to address the question of whether or not rumble strips should be included in the standard repertoire of tools used by county engineers.

Status: Work in progress

Active Projects

Contract 81655 WO 69

Principal Investigator:
Arturo Schultz, University of Minnesota

CoPrincipal Investigator:
Cathy French, University of Minnesota

Technical Liaison:
Jihshya Lin, Mn/DOT, Office of Bridges

Administrative Liaison:
Nelson Cruz, Mn/DOT

Contract Period:
6/1/2003 to 8/31/2006

Funding:
$160,000 STIP

Stability Tests of Prestressed Concrete Through-Girder Pedestrian Bridge under Lateral Impact - Phase II

Description:
To further develop and verify modifications to girder cross-section details and connection configurations for prestressed concrete pedestrian bridges.

Status: Work in progress

Project Relates To: Stability of Prestressed Through Girder Pedestrian Bridges - Phase I (CTS FUNDED)

Contract 81655 WO 62

Principal Investigator:
Lee Munich, University of Minnesota

Technical Liaison:
Ken Buckeye, Mn/DOT, Office of Investment Management

Administrative Liaison:
Jim Klessig, Mn/DOT
Sue Kahle, Mn/DOT

Contract Period:
12/1/2002 to 10/31/2006

Funding:
$89,600 COPTRS
$50,000 Construction
$107,900 Transportation Research (TRCA)
$990,000 Value Pricing

Minnesota Value Pricing Outreach and Education

Description:
To develop local champions and educate the citizens of Minnesota to help bring about value pricing implementation projects in Minnesota and to continue to expand communication efforts started in Minnesota, which have benefited other states as well.

Status: Work in progress

Contract WO 60

Principal Investigator:
Jerome Hajjar, University of Minnesota

Technical Liaison:
Edward Lutgen, Mn/DOT, Office of Bridges

Administrative Liaison:
Cory Johnson, Mn/DOT

Contract Period:
1/2/2003 to 10/31/2006

Funding:
$289,771 STIP

Load Rating by Load Testing on Bridges

Description:
Load rating of bridges is presently performed with simplified analysis methods that are generally very conservative. Load testing with vehicles with known axle weights can be used to calibrate or refine these analysis methods, thereby improving both their accuracy and their effectiveness distribution of load are not linear with increasing load.

Status: Work in progress

Active Projects

Contract 81655 WO 57

Principal Investigator:
Bojan Guzina, University of Minnesota

Technical Liaison:
John Siekmeier, Mn/DOT, Office of Materials

Administrative Liaison:
Sue Lodahl, Mn/DOT

Contract Period:
11/1/2002 to 6/30/2006

Funding:
$197,937 STIP

Moisture Effects on DCP and Portable Vibratory Deflectometer (PVD) Measurements - Phase II

Description:
To elevate the quality assurance practices and field testing of unpaved subgrade and granular base profiles, the proposed project will focus on the development of a laboratory procedure for understanding and quantifying the effects of moisture on the soil's stiffness and strength characteristics and relating the laboratory measurements to field estimates of the associated soil parameters.

Status: Draft Final Report received

Project Relates To: 74708 WO 185, 81655 WO 32, "Resilient Modulus Testing for MnPave" Implementation Funded Project, "Moisture Effects on DCP and PFWD Measurements - Phase I (CTS funded)"

Contract 81655 WO 44

Principal Investigator:
Gary Davis, University of Minnesota

Technical Liaison:
Ben Osemenam, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
2/1/2004 to 7/31/2006

Funding:
$52,000 Guidestar
$13,000 STIP

Safety Effects of Left Turn Phasing Schemes at High-Speed Intersections

Description:
To improve left-turn safety by studying the effect approach speed, traffic volume, and left-turn phasing have on accident risk.

Status: Work in progress

Project Relates To: 81655 WO 2, "Modeling Gap Acceptance at Merging Areas"

Contract 81655 WO 43

Principal Investigator:
Robert Johns, CTS, University of Minnesota

Technical Liaison:
Sue Lodahl, Mn/DOT, Office of Investment Management

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
7/1/2003 to 6/30/2006

Funding:
$1,305,561.60 Guidestar
$198,890.40 ITS Match
$127,500 STIP

Minnesota Guidestar Support - 2003

Description:
To provide continuation funding for the U of M's Center for Transportation Studies ITS Institute including laboratory development and operations and program and administrative fiscal support for the ITS Institute.

Status: Work in progress

Active Projects

Contract 81655 WO 33

Principal Investigator:
Max Donath, University of Minnesota

Technical Liaison:
Ray Starr, Mn/DOT, Office of Traffic, Security and Operations

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
9/3/2002 to 6/30/2006

Funding:
$13,149.47 COPTRS
$1,637,795.90 Caltran
$190,282 ITS Project Match
$234,208.63 STIP

Intersection Decision Support

Description:
This project is Minnesota's piece of a federal grant program which is focused on the improvement of safety at intersections. The overall objectives of the project are to improve safety and mobility with a system that is deployable, robust, easily maintained, and cost effective. The specific Minnesota contribution is to meet these goals for rural intersections found nationwide and to develop surveillance technology and collision predictive algorithms applicable to all intersection types.

Status: Report #2004-31 "Review of Minnesota's Rural Intersection Crashes: Methodology for Identifying Intersections for Intersection Decision Support (IDS)" and 2006-03 "Statistical Modeling for Intersection Decision Support" and three Draft Final Reports received

Contract 81547

Principal Investigator:
Dan Krivit, Dan Krivit and Associates

Technical Liaison:
Roger Olson, Mn/DOT, Office of Materials

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
3/23/2001to 9/30/2002

Funding:
$24,500 STIP

Using Scrap Shingles as a Road Construction Material - Implementation and Expansion

Description:
To implement a communications plan developed to market Manufactured Organic Shingle Scrap (MOSS) for use as an additive for roadway asphalt.

Status: Work in progress

Related Project: Contract 83109 "Using Tear-Off Scrap Shingles as a Road Construction Material (Overcoming the Barriers to Asphalt Shingle Recycling)"

Non-Contract
(2000-045P)

Principal Investigator:
Robert Weinholzer, Mn/DOT, Office of Traffic, Security and Operations

Technical Liaison:
Jason Alcott, Office of Environmental Services

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
None

Funding:
$50,832.44 STIP

Deer/Vehicle Collisions

Description:
To test the effectiveness of a new product, the "deer alert sign" in reducing the number of large animal/vehicle collisions.

Status: Work in progress

Active Projects

Non-Contract
(2001-006P)

Principal Investigator:
Marc Loken, Mn/DOT, Office of Materials

Technical Liaison:
John Stieben, Pine County

Administrative Liaison:
Jim Klessig, Mn/DOT

Contract Period:
None

Funding:
$75,000 LRRB
INV 771

Use of Ground Penetrating Radar to Evaluate Minnesota Roads

Description:
The use of ground-penetrating radar (GPR) is fast becoming a viable technology for surveying subsurface features and defects in flexible and rigid pavements worldwide. Several Mn/DOT districts have expressed an interest in using GPR to aid in surveying and scoping projects.

Status: Draft Final Report received

Non-Contract
(2001-019P)

Principal Investigator:
Tim Clyne, Mn/DOT, Office of Materials

Technical Liaison:
Lou Tasa, Mn/DOT, State Aid District 2

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
None

Funding:
$30,000 LRRB

Geosynthetics in Roadway Design

Description:
To determine if the geosynthetics decrease cracking and rutting while improving pavement ride.

Status: Work in progress and one deliverable NONE08 "Application of Geotextiles, Geogrids, and Geocells in Northern Minnesota"

Non-Contract
(2003-058C)

Principal Investigator:
Marc Loken, Mn/DOT, Office of Materials

Technical Liaison:
Brad Wentz, Becker County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
None

Funding:
$51,000 LRRB
INV 808

Pavement Rehabilitation Selection

Description:
This project will have the objective of laying out best practices for the selection of asphalt pavement recycling techniques from the many choices that are available. The project will specifically look at full depth reclamation (FDR), cold in place recycling (CIR), and mill/ overlay (M&O). This study will evaluate low and medium volume roads. Therefore sources of information in the county and state system can be used as resources for the project.

Status: Work in progress

Related Projects: 81655 WO 135 "Pavement Rehabilitation Selection" by Mn/DOT's Office of Materials $51,000 LRRB

Active Projects

Non-Contract
(2005-002P)

Principal Investigator:
Tom Wood, Mn/DOT, Office of Materials

Technical Liaison:
Tom Struve, City of Eagan

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
None

Funding:
$72,802
INV 822

Crack Sealing and Filling Performance

Description:
Improper crack sealing operations contribute to premature pavement failure and increased maintenance costs. An improved sealant selection process and a 'Best Practice Guide for Installation' will result in better sealant performance and in return, decreased maintenance and longer pavement life.

Status: Work in progress

Non-Contract
(2005-005P)

Principal Investigator:
Marc Loken, Mn/DOT, Office of Materials

Technical Liaison:
Michael Sheehan, Olmsted County

Administrative Liaison:
Ann McLellan, Mn/DOT

Contract Period:
None

Funding:
$40,000 LRRB
INV 825

Performance Monitoring of Olmsted CR 117/104 and Aggregate Base Material Update

Description:
Monitor these roads over a longer time period (i.e., five years) to study the effects of temperature (freeze-thaw), time (rutting and/or stripping) and traffic conditions (i.e., traffic counts and types) on the long-term performance. Monitor the spring-thaw performance of the three base types selected in the previous study, over two spring-thaw cycles, in order to quantify the benefits of these materials under spring thaw conditions. Update the material models for strength and modulus to consider these effects and ultimately implemented into MnPAVE. Continue the current "information exchange" with Norway, where open-graded bases are commonly and successfully used to alleviate spring-thaw concerns, by allowing for proper horizontal drainage into the ditches and minimizing the moisture exchange between the subgrade and base layers, as the frost interfaces from both layers approach each other.

Status: Work in progress

Non-Contract
(2005-006P)

Principal Investigator:
Eddie Johnson, Mn/DOT, Office of Materials
CoPrincipal Investigator:
Jim McGraw, Mn/DOT, Office of Materials

Technical Liaison:
John Brunkhorst, McLeod County

Administrative Liaison:
Clark Moe, Mn/DOT

Contract Period:
None

Funding:
$30,789 LRRB
INV 826

Appropriate Use of RAP

Description:
Some asphalt pavements that use RAP in their mix designs have shown earlier than expected failures. Cores and mixtures will be analyzed to determine why these mixes did not perform as expected. Recommendations on the appropriate use of RAP will be presented.

Status: Work in progress

Active Projects

Non-Contract
(2005-007P)

Principal Investigator:
Eddie Johnson, Mn/DOT, Office of Materials

Technical Liaison:
Gary Bruggeman, Steele County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
None

Funding:
$25,126 LRRB
INV 827

Investigation of Winter Pavement Tenting

Description:
Investigating the effect of deicing on frost heave has potential benefits for pavement design and maintenance. Identifying tent-susceptible designs help designers decide if a particular type of pavement is resistant to damage from frost and deicing. Maintenance personnel can use the research to decide if a specific deicing protocol is effective when combined with crack sealing.

Status: Work in progress

Non-Contract
(2005-008P)

Principal Investigator:
Bruce Chadbourn, Mn/DOT, Office of Materials

Technical Liaison:
Richard Larson, Mille Lacs County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
None

Funding:
$56,000 LRRB
INV 828

Local Road Material Properties and Calibration of MnPAVE

Description:
The lack of a Mechanistic-Empirical design alternative for local roads will be addressed by this research. A version on MnPAVE that has more detailed material properties and calibrated for local roads will provide a more accurate pavement design alternative for local officials.

Status: Work in progress

Non-Contract
(2005-011P)

Principal Investigator:
Robert Edstrom, Mn/DOT, Office of Environmental Services

Technical Liaison:
Ronald Mortensen, Meeker County

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
None

Funding:
$100,000 LRRB
$50,000 Pollution Control Agency
INV 773

Shredded Tires Used for Road Bases; Part 2, Environmental Services Analysis of Samples

Description:
This research will provide scientifically valid data to regulators and environmental specialists sufficient to determine if waste tires can be shredded and used in an environmentally safe manner in Minnesota. If the research determines that shredded tires can be used in an environmentally safe manner, Mn/DOT and other local transportation agencies will have another readily available resource to use for aggregate purposes.

Status: Work in progress

Active Projects

Non-Contract
(2005-039P)

Principal Investigator:
Dave Johnson, Mn/DOT, Office of Materials

Technical Liaison:
Dave Robley, Douglas County

Administrative Liaison:
Sue Kahle, Mn/DOT

Contract Period:
None

Funding:
$55,000 LRRB
INV 837

MnROAD Reconstruction of Low Volume Road

Description:
Repairs to Cells 29, 30, 24 and 25 of low volume loop of MnROAD.

Status: Work in progress

Non-Contract
(2005-042P)

CoPrincipal Investigator:
Tim Clyne, Mn/DOT, Office of Materials
CoPrincipal Investigator:
Hein Stefan, University of Minnesota

Technical Liaison:
Chris Cochran, Mn/DOT, Office of Materials

Administrative Liaison:
Dan Warzala, Mn/DOT

Contract Period:
None

Funding:
$20,000 LRRB (lab portion)
INV 817

Determination of Optimum Time for the Application of Surface Treatments to Asphalt Concrete Products

Description:
The objective of this work is to provide a better understanding of the mechanism by which surface treatments protect the existing pavement from further aging and deterioration due to traffic and environmental loadings and to reasonably predict the optimum time for the application of these treatments. This requires a reasonable understanding of the progression of the complex aging mechanism in asphalt materials as well as the effect of aging on their fracture resistance. It is expected that this research will provide preliminary guidelines in terms of type of treatment and timing of the application. Continuous monitoring of field performance for longer periods of time combined with additional laboratory investigations and data analysis will be required to improve the prediction of the optimum times for the application of surface treatments.

Status: Work in progress

Related Project: Contract 81655 WO 137

List of Research Implementation Committee Projects

2005-2006

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Active Projects RIC Projects

Contract 87369
(2004-053I)

Principal Investigator:
Mike Marti, SRF Consulting Group, Inc. and Braun Intertec

Technical Liaison:
Lou Tasa, Mn/DOT, State Aid District 2

Administrative Liaison:
Clark Moe

Contract Period:
3/18/2005 to 2/28/2007

Funding:
$26,923 LRRB

Training Module for Designing and Constructing with Geosynthetics—Task 2

Description:
Over a period of many years LRRB investigations have identified best practices for the design and construction of low volume roads using Geosynthetics. These best practices have been summarized in the form of reports, RIS's, PowerPoint's, and a CD-ROM, most of which reside on the LRRB's web site at www.lrrb.org. In addition to these local efforts, the Federal Highway Administration (FHWA) has developed training modules incorporating best practices for the design and construction of low volume roads using Geosynthetics. The objective of this task is to develop a training module integrating the best practices resulting from LRRB research, utilizing the training module already developed by the FHWA. The deliverable for this task is a one-day training module that includes an instructor's guide as well as a take-away manual for participants.

Status: Work in progress

Contract 87369
(2004-054I)

Principal Investigator:
Mike Marti, SRF Consulting Group, Inc.

Technical Liaison:
Mark Maloney, City of Shoreview

Administrative Liaison:
Ann McLellan

Contract Period:
3/18/2005 to 2/28/2007

Funding:
$18,848 LRRB

Update Seal Coat Handbook / Training Module—Task 3

Description:
The LRRB handbook, Mn/DOT Publication No.1999-07, provides a solid background in seal coat materials, equipment, design and construction for the field inspector. Since publishing this handbook, research has developed new materials specifications and identified new methods for application. The objective of this task is to review these specifications and methods which then will be used to update the handbook. Useful portions of the existing handbook will be salvaged. In addition to updating the handbook, the Selected Responder will develop a 2 4 hour seal coat training module for state and local agency maintenance and construction personnel. This module will be based on information from the updated handbook. The deliverables for this task are an updated Minnesota Seal Coat Handbook and a 2 to 4 hour training module that includes an instructor's guide.

Status: Draft Handbook and PowerPoint Presentation

Contract 87369
(2004-055I)

Principal Investigator:
Mike Marti, SRF Consulting Group, Inc.

Technical Liaison:
John Rodeberg, City of Hutchinson

Administrative Liaison:
Clark Moe

Contract Period:
3/18/2005 to 2/28/2007

Funding:
$20,692 LRRB

Review Existing LRRB/RIC Products—Task 4

Description:
The LRRB and RIC have developed many reports and products over a period of many years. Many of these are referenced or reside on the LRRB's website at www.lrrb.org. The objective of this task is a review of these documents and references to determine if they should be completely removed, referenced only, provided full online access (PDF) to, or updated. For those in need of updating, the purpose, tasks and costs associated with updating the individual product will be provided. The recommended deliverable for this task is a summary report.

Status: Work in progress

Active Projects RIC Projects

Contract 87369
(2004-056I)

Principal Investigator:
Mike Marti, SRF Consulting Group, Inc.

Technical Liaison:
Rick Kjonaas, Mn/DOT, State Aid

Administrative Liaison:
Barb Loida

Contract Period:
3/18/2005 to 2/28/2007

Funding:
$41,590 LRRB

FHWA Project Documentation Tool—5

Description:
The objective of this task is to design a tool that would identify the issues that require study and advise the user how to document the results of the studies, assist in the determination of what type of report is required, if any, and what level of public involvement is required, if any. The proposed tool should have the same look and feel as the Project Tracking and NEEDS programs already in use by State Aid's clients, with a possible interface to capture data from the Project Tracking program. The tool would query the user for required information and provide for the printing of reports for project memos, environmental assessments, design memos, and Section 4(f) evaluations. The tool would be available for use on the State Aid for Local Transportation Division (SALT) website, with project data available for review, as needed, by local agencies, the District State Aid Engineers, SALT staff, and the FHWA. The recommended deliverable for this task is a database with screens relating to various parts of project development documents, i.e., project location description, proposed project description, costs and funding, environmental impacts, public and agency involvement, design elements, etc.

Status: Demonstration given at the county and city engineer conferences.

Contract 81655 WO 167 and 2004-050P

Principal Investigator:
Mn/DOT, Office of Materials and Joseph Labuz, University of Minnesota

Technical Liaison:
Dan Sauve, Clearwater County

Administrative Liaison:
Clark Moe

Contract Period:
6/30/2005 to 9/29/2006

Funding:
$42,000 LRRB
$25,000 STIP

Ground Penetrating Radar Capability Brochure/Demo and Implementation—Task 8

Description:
The objective of this task is to produce a test method document identifying the recommended procedures for using GPR resulting from LRRB INV 771. It will also include demonstrations in each district in an effort to inform local engineers on the benefits of using GPR which include potential cost savings, increased safety and time savings.

Status: Work in process

Contract 81655 WO 219

Principal Investigator:
Jim Grothaus, CTS, University of Minnesota

Technical Liaison:
Michael Sheehan, Olmsted County

Administrative Liaison:
Clark Moe

Contract Period:
5/4/2006 to 10/31/2006

Funding:
$12,000 LRRB

To Pave or Not to Pave—Task 11

Description:
Two recently completed research reports have been published which attempts to provide local officials with methods to determine at what point it is desirable to upgrade a gravel road to a paved road. LRRB INV 769, report #2005-09 titled "Economics of Upgrading an Aggregate Road", and, S. D. report # 2002-10 titled "Development of Surfacing Criteria for Low Volume Roads in South Dakota". The purpose of this task is to develop educational materials based on these reports which will be used to acquaint local engineers and officials with the factors involved with the decision process and methods used. These training materials will be delivered through CTAP to Township Officers and also through the LTAP workshop titled "Gravel Roads Maintenance and Design.

Status: Work in process

DVD TE278 Brochure

Principal Investigator:
Michael Marti, SRF Consulting Group, Incorporated

Implementation Coordinator:
Mark Maloney, City of Shoreview

Implementation Liaison:
Clark Moe, Mn/DOT

Contract:
87369
(2004-057I)

Contract Period:
3/18/2005 to 2/28/2007

Completed:
2/6/2006

Funding:
$90,304

Program:
2005-2006 RIC
INV 645
Task 6

Loads and Roads: Finding the Balance—Task 6

Description:
In 1991 the LRRB developed a video describing how pavement materials are affected by the weather and loading. This video taught the basic concepts of pavement engineering including fatigue, bearing capacity, and thermal expansion. It also identified a set of cross-sectional pavement models which were used to show how pavements respond to weather and loading. Since 1991, changes have been made relating to pavement engineering, legislation, and loading practices. The objective of this task is to update this video, incorporating recent changes relating to weather and roads and the effects they have on roads. The deliverable for this task is a video and associated outreach materials.

Summary:
This 19-minute long DVD is organized in discrete segments covers the following issue areas. Introduction; Pavement Design Basics; How Loads Impact Roads; Spring Load Limits; Finding a Balance; and Play All. The DVD also features engineers, law enforcement personnel, elected officials, and truckers and haulers being interviewed about their experiences with the issue of loads and roads in Minnesota.

Activities:
Mike Marti presented this DVD at the 10th annual Pavement Conference on February 16, 2006.

Material Located At:
DVD TE278 and Brochure can be obtained by calling Research Services at 651/282-2274 or the Mn/DOT Library at 651/296-2385.

Report #2005-33

Principal Investigator:
Dan Frentress, Frentress Enterprises, LLC

Implementation Coordinator:
Michael Sheehan, Olmsted County

Implementation Liaison:
Clark Moe

Contract:
87398

Contract Period:
12/13/2004 to 12/30/2005

Completed:
2/6/2006

Funding:
$25,000 LRRB

Program:
2005-2006 RIC
INV 645
Task 9

Best Practices Manual for Rehabilitation of Low Volume Concrete Roads in Minnesota—Task 9

Description:
This objective of this task is to produce a manual which provides information necessary to assist local engineers and maintenance personnel in the application of the best practices of rehabilitation to the problems which exist on their low volume concrete roads. The manual is to include methods which are most applicable to Minnesota conditions. The description of the methods will include a list of deficiencies that warrant rehabilitation, the cause of the deficiencies, and the list of materials, equipment and personnel skills necessary to properly rehabilitate one or more pavement deficiencies.

Summary:
This manual has been designed to be used as specifications for concrete repair of local city streets and county concrete pavements. It is intended to be used as supplemental specifications for constructing this work throughout the state of Minnesota. All standard plates have been designated as SA, which is an abbreviation for State Aid. This is intended to allow the State Aid office to track bid prices with a consistent title throughout the state. This manual was developed from existing concrete repair standards that have been developed and used by Mn/DOT since 1981. This manual also incorporates successful modifications to the Mn/DOT standards by the City of Owatonna and the City of Austin, Mn. This manual keeps the Mn/DOT system of labeling repairs in the A,B,C nomenclature developed in 1981 as follows; SA-A repairs are joint or crack repairs. SA-B repairs are partial depth repairs. SA-C repairs are full depth concrete repairs. For the first time this manual incorporates standards for sidewalk and curb and gutter repairs into a specification format. These sidewalk and curb and gutter standards have been successfully performed by the cities of Austin and Owatonna, Minnesota.

Activities:
Matt Zellar presented on this project (SALT Standards) at the 10th annual Pavement Conference.

Report Located At: http://www.lrrb.org/pdf/200533.pdf

No Deliverable

Principal Investigator:
Paul Bloom, University of Minnesota

Implementation Coordinator:
John Rodeberg, City of Hutchinson
and
John Siekmeier, Mn/DOT, Office of Materials

Implementation Liaison:
Clark Moe

Contract:
81655 WO 154

Contract Period:
2/16/2005 to 5/31/2006

Funding:
$14,000 LRRB

Program:
2005-2006 RIC
INV 645
Task 10

Screening Tool for Using Waste Materials (fly ash) in Paving Projects - Demo/Training—Task 10

Description:
Minnesota Local Engineers have limited staff necessary to decode and evaluate the mounds of data available from the Department of Public Safety (DPS) and Mn/DOT. The purpose of this task is to develop a tool that serves as an interface between this crash data and Mn/DOT's GIS base map. The tool will include mapping, query and reporting tools which are extensible and configurable to work with and analyze a variety of geo-referenced data. The development and delivery of 10-four hour training sessions to local agencies will also be part of this task.

Summary:
There are many potential benefits from using coal ash in road construction projects. There are also concerns about negative changes to the environment when using coal ash. The training will describe an environmental screening tool that looks at the soil, the ash and the climate and then uses calculated MPCA Soil Reference Values and Soil Leaching Values to estimated acceptable levels of 16 specific elements. With this tool you can use chemical data to calculate the environmental risk of using coal ash in soils.

Activities:
Training for this project was held in Arden Hills and Waseca in 2005 and Detroit Lakes, Crookston, and Willmar in 2006.

Web Tool
http://saltweb/crashmaptool.html

Principal Investigator:
Reginald Souleyrette, University of Iowa

Implementation Coordinator:
Susan Miller, Freeborn County

Implementation Liaison:
Clark Moe

Contract:
82617 WO 10

Contract Period:
11/11/2005 to 1/31/2007

Funding:
$12,000 LRRB
$45,000 Pooled Fund

Program:
2005-2006 RIC
INV 645
Task 12

Crash Mapping Analysis Tool for Minnesota DOT —Task 12

Description:
Minnesota Local Engineers have limited staff necessary to decode and evaluate the mounds of data available from the Department of Public Safety (DPS) and Mn/DOT. The purpose of this task is to develop a tool that serves as an interface between this crash data and Mn/DOT's GIS base map. The tool will include mapping, query and reporting tools which are extensible and configurable to work with and analyze a variety of geo-referenced data. The development and delivery of 10-four hour training sessions to local agencies will also be part of this task.

Summary:
The CRASH Mapping and Analysis Tool enables the user to analyze crashes based on a number of crash attributes, including county, city, township, coordinates, milepost, node, intersection (road-road, rod-rail, road-river), DOT case number, and local law enforcements case number. The software produces a color map with plotted crash sites, a series of charts based on crash attributes, and automated repots based on selected attributes of crashes. By using this tool, county professionals will be able to more efficiently reduce the number and severity of crashes within these areas.

Activities:
None noted

Web Tool Located At: http://saltweb/crashmaptool.html

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List of Research Implementation Committee Projects

2003-2004

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NONE15	**3**	Taconite Tailings and their use in Road Construction - Brochure	325
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NONE16 Web Tool	**7**	Low Volume Road/HMA Design Tool	329
2005-11	**8**	Partners for Good: A Resource Guide for Partnership Efforts in Minnesota Cities and Counties	330
No Report	**10**	Truck Weight Compliance Education Program—DONE	331

Report #2005-12

Principal Investigator:
Michael Marti,
SRF Consulting Group, Incorporated

Implementation Coordinator:
John Rodeberg,
City of Hutchinson

Implementation Liaison:
Jim Aamot

Contract: 83994 (2003-010I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
April 20, 2004

Funding:
$21,400.96
LRRB

Program:
2003-2004 RIC
INV 655

Project Management Software: Practical Applications for Improved Project Management - Task 2

Description:
Most cities and counties have their own databases to track financial information related to public improvement projects, but comprehensive databases, related to the tracking, dissemination, organization and filing of project activities (schedules and project review notes, documents and drawings) and other information, are very limited. The scope of this task will be to survey and interview local governments to evaluate their use of existing project management software. If products are not available commercially, a review of the potential and cost to modify existing or to develop new software should be undertaken.

Summary:
This paper looks at the various ways project management software is being utilized in Minnesota's transportation projects and how the right software is selected.

Activities: None noted

Report Located At: http://www.lrrb.org/pdf/2005/200512.pdf

Report #NONE15

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Implementation Coordinator:
Dan Sauve, Clearwater County

Implementation Liaison:
Clark Moe

Contract:
83994
(2003-011I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
December 14, 2004

Funding:
$19,729.32
LRRB

Program:
2003-2004 RIC
INV 645

Taconite Tailings and their use in Road Construction Brochure - Task 3

Description:
The LRRB project, Investigation #758, studied the Properties and Aggregate Potential of Taconite Tailings. This task calls for the assembly of experts and beneficiaries to discuss the findings of this report, provide potential uses of this product and design communication and education tools (workshop, seminar, power point etc.) necessary to educate the end users of this product. The communication and education tools will be designed to easily incorporate into training activities. The deliverable for this task is a report along with the selected communication and education tools.

Summary:
This documentation is for local and state practitioners in the use of taconite in road constructions. Taconite has been successfully used in Minnesota from 2001 to 2004 as part of a wear course or as a base material. Taconite tailings have high strengths and hardness and the cost of production is much lower than for traditional aggregate mining. Taconite tailings can be used as an alternative source of aggregate for highway construction.

Activities:
Larry Zanko presented at the May 24 2006 CTS Research Conference "An Overview of Taconite Aggregate Research Efforts

This project is explained in an article in the University of Minnesota's "Minnesota Technology Exchange" Spring 2003, Vol. 11, No.2.

Project was highlighted in the "Minnesota Technology Exchange", Fall 2004, Vol. 12, No.4 , article titled "Taconite Tailings: A New Source of Aggregate for Roadway Construction".

Outcome:
Change with no measures.

Report Located At:
Brochure

Report #2005-27

Principal Investigator:
Cameron Kruse, Braun Intertec Corporation

Implementation Coordinator:
Mike Sheehan, Olmsted County

Implementation Liaison:
Clark Moe

Contract:
83994 (2003-012I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
December 14, 2004

Funding:
$23,784.35
LRRB

Program:
2003-2004 RIC
INV 645

Synthesis of Current Minnesota Practices of Thin and Ultra-Thin Whitetopping - Task 4

Description:
Two LRRB projects studied the uses of thin and ultra thin whitetopping. They are "INV 729: Ultra-Thin and Conventional White Topping at MnROAD" and "INV 748: Cost and Performance Evaluation of Ultrathin Pavements on High Volume Intersections". In addition to the reports for these projects, several papers were written for the thin whitetopping projects. Although the ultimate development of procedures is some time away, this task will develop design and construction guidelines based on current knowledge, including when to use thin and ultra-thin whitetopping. The guidelines will address things like optimization of pavement life. The deliverable for this task is a set of guidelines that will be published as a report and include a draft tech memo on the use of whitetopping or a recommendation not to use whitetopping at this time.

Summary:
This report documents the current practices of Minnesota in rehabilitating Hot Mix Asphalt pavement with thin and ultra-thin Portland cement concrete overlays, i.e. thin and ultra-thin whitetopping. The current practices of thin whitetopping (TWT) in Minnesota and its adjacent states have shown that TWT has been used successfully and is an important alternative for rehabilitating HMA pavements of medium volume roads. If designed and constructed properly, TWT is also an important alternative for rehabilitating HMA pavements of highway volume roads with more requirements in HMA quality, bonding and fiber reinforcement. The performance of ultra-thin whitetopping (UTW) projects in Minnesota ranges from very good to failing. The sections that perform poorly are short sections under stopping trucks or buses and over thin or poor condition HMA pavement. UTW has been used successfully in Minnesota when inlaid into thick and sound HMA pavements even in high-volume traffic. The quality of the HMA substrate, bonding, fiber reinforcement, and joint spacing all significantly affect the success of UTW. The great caution should be used when rehabilitating HMA pavements at bus stops, weigh stations, and intersections. Mn/DOT does not recommend UTW for major highways and heavy traffic areas.

Activities:
This project is explained in an article in the University of Minnesota's "Minnesota Technology Exchange" Spring 2003, Vol. 11, No.2. Dr. Chunhau presented project draft results at the Minnesota Pavement Conference on February 17, 2005.

Report Located At: http://www.lrrb.org/pdf/2005/200527.pdf

Report #2004-40

Principal Investigator:
Ann Johnson, Professional Engineering Services Limited

Implementation Coordinator:
Don Theisen, Washington County

Implementation Liaison:
Jim Klessig

Contract: 83994 (2003-013I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
September 22, 2004

Funding:
$15,568.16
LRRB

Program:
2003-2004 RIC
INV 645

Use of Warranties in Highway Construction - Task 5

Description:
The focus of the project is on the city and county agencies in evaluating the current state of the practice for public agencies using warranties in roadway construction. This report is an update to the earlier LRRB RIC Report 1999-37 and summarizes NCHRP Report 451.

Summary:
Participants at the FHWA warranty symposium held in 2002 believe that warranties will continue to grow for use on selected projects. Nearly half the participants see warranties evolving as standard practice. The states also believe that they need to
develop guide specifications, best practices, and practical case studies in order to improve the warranty value.

Mn/DOT also continues to develop warranty specifications and guidelines on state projects. We can expect to see warranties in concrete pavement construction, and as experience is gained and acceptance grows within the contractor community, it will
become easier for local agencies to implement their own warranty programs.

Many tools have been referenced or included in this report to assist the local engineer with developing a warranty program. Additional resources and experts exist at Mn/DOT. Those local agencies interested in implementing a warranty program are encouraged to identify a pilot project, and follow the steps listed in Section VI of this report. Continuous evaluation and revision is required for a successful warranty program at the state or local level.

Activities:
Ann Johnson presenting "Local Agency Use of Warranties" at the MAAPT Conference on December 7, 2004 and she presented the project results at Minnesota Pavement Conference on February 17, 2005

Report Located At: http://www.lrrb.org/pdf/2005/200540.pdf

Report #2005-34

Principal Investigator:
Mike Marti,
SRF Consulting Group, Inc.

Implementation Coordinator:
Rick Kjonaas,
Mn/DOT, State Aid

Implementation Liaison:
Dan Warzala

Contract:
83994 (2003-014I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
December 14, 2004

Funding:
$24,349.12
LRRB

Program:
2003-2004 RIC
INV 645

Best Practices for Streamlining Construction Project Activities - Task 6

Description:
Recent efforts have been made to streamline design project activities. This task will explore current activities, techniques, and materials used to streamline construction activities. This task should survey, interview, review and evaluate contractors, consultants, local agencies and DOTs for current practices used. Cost/benefit evaluations will also be included in this task. The deliverable for this task is a report.

Summary:
Recent initiatives at the state and federal level have focused attention on possible ways of streamlining or expediting the project delivery process. While some of these efforts have focused on methods and practices to speed planning and pre-construction activities, the purpose of this investigation was to examine means of speeding the roadway and highway construction cycle. Highway construction time has very real costs to all parties involved in the process; highway departments, contractors, and most especially the public whose tax dollars and time is spent waiting for projects to be completed. Recognizing this, the Local Road Research Board's (LRRB) Research Implementation Committee (RIC) began this investigation to explore current activities, techniques and materials whose use reduces construction time, and to determine the extent of their use by city and county engineers in Minnesota.

Activities:
None noted

Report Located At: http://www.lrrb.org/pdf/2005/200534.pdf

Report #NONE16
Website Tool

Principal Investigator:
Mike Marti,
SRF Consulting Group, Inc.

Implementation Coordinator:
Dave Johnson,
Mn/DOT, Office of Materials

Implementation Liaison:
Clark Moe

Contract:
83994
(2003-014I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
December 14, 2004

Funding:
$27,683.26
LRRB

Program:
2003-2004 RIC
INV 645

Hot Mix Asphalt Design Tool - Web based —Task 7

Description:
The purpose of this Web tool is to assist the engineering community in the design of hot mix asphalt (HMA) pavements. This website will also direct the user to results provided within The Best Practices for the Design and Construction of Low Volume Roads, LRRB Report 2002-17REV.

Summary:
Three LRRB projects have been completed to produce Best Practices for the Design and Construction of Low Volume Roads. They are titled "INV 747: Best Practices for the Design and Construction of Low Volume Roads," "INV 754: Traffic Supplement to Low Volume Road Best Practices Manual" and "INV 772: Design and Construction of Pavement Embankments in Minnesota." These best practices include numerous references to specifications and resources now available on-line. In addition, they are dependent on the use of the MnPAVE software for application of its recommendations. This task calls for the conversion of these best practices to a Web-based, interactive user application. As part of this task, an evaluation and comparison to the existing on-line Asphalt Paving Guide will be made. Salvaging and replacing the useful portions of the existing Asphalt Pavement Guide into the new web application will be considered as part of this task. This Web application will allow updates to be easily made as new research and specifications become available.

Activities:
This project is explained in an article in the University of Minnesota's "Minnesota Technology Exchange" Spring 2003, Vol. 11, No.2. Mike Marti presented "HMA Design Tool" at the MAAPT Conference on December 7, 2004.

Report Located At: Website Tool found at:
http://www.dot.state.mn.us/stateaid/hma_tool/index.html

Outcome: Change with no measures

Report #2005-11

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Implementation Coordinator:
Mark Maloney, City of Shoreview

Implementation Liaison:
Clark Moe

Contract:
83994 (2003-016I)

Contract Period:
May 1, 2003 to April 30, 2005

Completed:
December 14, 2004

Funding:
$22,103.42 LRRB

Program:
2003-2004 RIC INV 645

Partners for Good: A Resource Guide for Partnership Efforts in Minnesota Cities and Counties - Task 8

Description:
This report explores the use of partnerships from making efficient resource decisions to how major public works projects can be implemented through the concerted efforts of local government units.

Summary:
Joining forces in a partnership relationship is a way for different entities to come together and, building on their respective strengths and abilities, realize together what they could never have realized separately. Although partnership relationships are typically a profitable means for local governments to explore in implementing projects, they become even more compelling when resources are limited and multiple needs compete for scarce available dollars. This paper explores the use of partnerships in Minnesota to advance needed public works projects. It discusses some of the nuances of what partnerships can mean to local units of government, from the ways in which bartering of services, equipment, and staff expertise allows local units of government to make efficient resource decisions to how major public works projects can be implemented through the concerted efforts of interested partners. Through the use of focus group discussions, selected case studies, and the expertise of the Technical Advisory Panel (TAP) overseeing this effort, a best practices guide to Minnesota city and county partnering efforts results.

Activities
Wayne Fingalson, John Rodeberg and Tom Struve presented ""Match Made in Minnesota A Review of Partnerships/Barterships in Minnesota: Framework, Principles, Successes" at the November 18-19, 2004 MPWA Conference.

A Question and Answer session was held at the fall 2004 MPWA conference regarding the results of this project. Attendees (53 representatives from local agencies) were asked to describe their experiences with partnering.

Report Located At: http://www.lrrb.org/pdf/2005/200511.pdf

No Deliverable

Principal Investigator:
Cheri Marti,
CTS, University of Minnesota

Technical Liaison:
Rick Kjonaas,
Mn/DOT, State Aid

Administrative Liaison:
Clark Moe

Contract:
81655 WO 73
(2003-014I)

Contract Period:
June 9, 2003
to
September 30, 2005

Funding:
$100,000 LRRB
$170,000 State Aid

Program:
2003-2004 RIC
INV 645

Truck Weight Compliance Education Program —Task 10

Description:
Education program for freight shippers, over-the-road freight carriers, and public agency personnel on the proper application of Minnesota Commercial Vehicle Weight Laws and Enforcement Policies.

Summary:
Each year, truck traffic is increasing. The number of trucks registered in Minnesota is growing. More highway improvements are being done and more routes are being paved. Damage to routes from overweight trucks is a concern of state, county, city, and township transportation authorities. The possibility of truck weight enforcement may need to increase as transportation agencies want to protect their highway investments from the heavier truck traffic.
Do you know the legal weight of your trucks?
Do you know when the legal weights change?
Do you know that your weights change depending on your route?
Learn about truck weights by learning about the laws governing

- Gross Weights
- Axle Weights
- Tire Weights
- Road Restriction Weights
- Seasonal Increased (Winter and Harvest) Weights

Activities:
Training was provided Fall 2003-Spring 2004 at approximately 16 sites.

Report Located At: None

Related Projects:
Contract 81655 WO 205 “Truck Weight Compliance Education and Outreach Program”

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List of Research Implementation Committee Projects

2001-2002

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Report #RIS-27

Principal Investigator:
Michael Marti,
SRF Consulting Group, Inc.

Implementation Coordinator:
Dan Sauve,
Clearwater County

Implementation Liaison:
Ann McLellan

Contract:
81424
(2001-005I)

Contract Period:
March 15, 2001
to February 27, 2004

Completed:
October 30, 2003

Funding:
$10,468
LRRB

Program:
2001-2002 RIC
INV 645

Effective Methods to Repair Frost Damage Roadways - Task 1

Description:
A guide to appropriate repair methods for frost damaged roadways is presented for different subgrade consistencies and subgrade drainages. The most successful repair treatments address both subgrade quality/ uniformity and surface/subgrade drainage.

Conclusions:
No repair method is universal; the evaluation of appropriate treatments requires:

- An understanding of site conditions,
- An assessment of the impact that *subgrade quality, uniformity, surface and subsurface drainage*, have had on the development and propagation of frost damage,
- And the best available materials, equipment, and funding.

The worksheet is provided as a guide to help select the appropriate treatment. In general, the most successful treatments address both subgrade quality/uniformity, and surface/subgrade drainage.

Activities:
October 2003 LRRB “UPDATE”. Article titled "Find the best way to repair frost-damaged roadway". This project is explained in an article in the University of Minnesota's "Minnesota Technology Exchange" Spring 2003, Vol. 11, No.2.

Report Located At:
Call the Mn/DOT Library at 651/296-2385 and ask for RIS-27

Report #2002-32

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Implementation Coordinator:
Mike Sheehan, Olmsted County

Implementation Liaison:
Dave Johnson

Contract:
81424 (2001-006I)

Contract Period:
March 15, 2001 to February 27, 2004

Completed:
October 21, 2002

Funding:
$24,155
LRRB

Program:
2001-2002 RIC
INV645

Synthesis of Asphalt Recycling in Minnesota - Task 2

Description:
This report summarizes the asphalt-recycling practices of Minnesota cities and counties (through survey results). Also included are parts of the Basic Asphalt Recycling Manual (BARM) that are especially applicable to Minnesota roadways.

Conclusions:
Research over the past ten years indicates that cold in-place and hot asphalt recycling can be effectively used in road maintenance and construction. The research also suggests that there are instances in which one method is preferred over the other. Because the amount of research that has occurred over the past ten years has been so voluminous, and because new modifications to the process frequently occur, it can be quite difficult for practitioners to identify the technique that is most suited to their needs.
The purpose of this document is to provide:

- Practitioners with a reference guide on asphalt recycling
- References for more specific information and where it can be located
- Compilation of Minnesota local government experiences

Activities: None noted

Report Located At: http://www.lrrb.gen.mn.usPDF/200232.pdf

Report #2003-33

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Implementation Coordinator:
John Rodeberg, City of Hutchinson

Implementation Liaison:
Jim Klessig

Contract:
81424 (2001-007I)

Contract Period:
March 15, 2001 to February 27, 2004

Completed:
October 21, 2002

Funding:
$20,330
LRRB

Program:
2001-2002 RIC
INV 645

Utility Relocation: A communication and Coordination Process for Local Government - Task 3

Description:
This report reviews recent efforts to facilitate utility relocation as part of roadway construction. Coordination resources are identified, and findings are presented from a survey of county and city engineers, utility companies, and construction contractors. The report provides recommendations and materials to make utility relocation processes more efficient and effective at the city and county levels.

Conclusions:

Conclusions from the ABAQUS Models

Existence of the pre-release cracks caused stress changes throughout the depth of the models near the crack location. The reduced moment of inertia at the crack section resulted in an increase in compressive stress near the crack tip location, and reduction in compressive stress at the bottom of the models as compared to the models of uncracked beams. The areas near the top of the section had reduced compressive stress due to the top portion of pre-release cracks remaining open during initial stages of loading.

Conclusions from the Beam Tests

The experimental results verified the results of the analytical study. The beams involving pre-release cracks experienced strain changes from the beams without pre-release cracks. Existence of pre-release cracks caused changes in the bottom fiber strain distributions. There was a considerable increase in the superimposed bottom surface tensile strains below the pre-release cracks. The effect was localized around the pre-release cracks, and decayed almost completely at a distance equal to the depth of the beams away from the crack location.

Activities:
Mike Marti gave a power point presentation on this project at the 14th Annual CTS Research Conference.

Report Located At: http://www.lrrb.gen.mn.usPDF/200333.pdf

Report #2002-31

Principal Investigator:
Dave Montebello, SRF Consulting Group, Inc.

Implementation Coordinator:
Mike Sheehan, Olmsted County
and
Wayne Fingalson, Wright County

Implementation Liaison:
Ann McLellan

Contract: 81424 (2001-009I)

Contract Period:
March 15, 2001 to February 27, 2004

Completed:
December 2, 2002

Funding:
$24,701
LRRB

Program:
2001-2002 RIC
INV 645

Best Practices for Rural Entrance Policy - Task 5

Description:

Best Practices for planning, designing and implementing land use and transportation strategies to manage access to land development while simultaneously preserving the flow of traffic on the public road system. The report includes references for developing or refining local policies.

Conclusions:

The LRRB identified a need to investigate access policies and design guidelines for lower-volume rural facilities. Currently, many townships, cities and some rural counties do not have entrance policies and design standards. This report provides rationale on why access should be managed in rural areas, and it identifies fundamental planning principles, design guidelines and best management practices for lower-volume rural roadways. This information may be shared with planning commissioners, local agencies and developers to improve decision-making and the understanding of rural access issues. In addition, this report provides references to other studies and information that can be used to develop or refine local policies.

Why manage access in rural areas? The rationale for managing access in rural areas is somewhat different than in urbanized centers or developing areas. Facilities in rural areas usually serve low-density land uses and have volumes that are well below capacity thresholds; therefore, capacity and disruptions to through traffic are less significant. As a result, the primary reasons for managing rural access are safety (e.g., sight distance, number of conflict areas, and severity of crashes when vehicles run-off-the-road) and operational/maintenance issues (e.g., snow removal, resurfacing, and drainage).

Activities:

Wayne Fingalson gave a power point presentation on this project at the 14th Annual CTS Research Conference on April 29, 2003. Article "Rural access policies: best practices around the state" Winter 2003 Vol. 11, No. 1 University of Minnesota "Minnesota Technology Exchange". 12/02/02: Report on LRRB web site.
Hard copies of the report were sent to city, county, and State Aid Engineers and subcommittee members on February 20, 2003. This project is explained in an article in the University of Minnesota's "Minnesota Technology Exchange" Spring 2003, Vol. 11, No.2.

Report Located At: http://www.lrrb.gen.mn.usPDF/200231.pdf

VT16 (video), NONE09, (brochure), NONE10 (Draft Model Policy)

Principal Investigator:
Andy Mielke, SRF Consulting Group, Inc.

Implementation Coordinator:
Mark Maloney, City of Shoreview

Implementation Liaison:
Dan Warzala

Contract:
81424 (2001-010I)

Contract Period:
March 15, 2001 to February 27, 2004

Completed:
July 22, 2003

Funding:
$25,032
LRRB

Program:
2001-2002 RIC
INV 645

Mailboxes May Be Hazardous to Your Health - Task 6

Description:
Video illustrating how non-conforming, improperly installed mailboxes can be roadside hazards. Examples of crash tests performed on mailboxes and support systems showing dangers of non-conforming mailboxes.

Conclusions:
This LRRB color brochure alerts readers to mailbox legislation, describes acceptable and hazardous mailbox installations (with photo examples), and gives steps for replacing hazardous mailboxes.

This mailbox model policy is designed to be tailored for individual local government use to provide state standardization and reduce liability. Mailbox legislation is cited, and detailed specifications on mailbox structure are given, including illustrations.

Activities:
Jim Grothaus used these brochures as part of the Traffic Control training through LTAP.

Report Located At:
ROCHURE TITLE: Is Your Mailbox a Hazard? NONE09
http://www.lrrb.gen.mn.us/pdf/FINAL_Mailbox_Brochure.pdf

Draft Model Policy for the Safe Placement of Mailboxes and Their Support Systems, Report#NONE10
http://www.lrrb.gen.mn.us/pdf/Final_Model_Policy.doc

Mailboxes May Be Hazardous to Your Health Video, VT16. Call the Mn/DOT Library at 651/296-2385 for a copy of the video.

Report #2003-23 & 2003-39

Principal Investigator:
Michael Marti, SRF Consulting Group, Inc.

Implementation Coordinator:
Richard Hansen, formerly St. Louis County

Implementation Liaison:
Dan Warzala

Contract: 81424 (2001-011I)

Contract Period:
March 15, 2001 to February 27, 2004

Completed:
December 17, 2003

Funding:
$24,479
LRRB

Program:
2001-2002 RIC
INV 645

Snow and Ice Control on Gravel Roads - Instructor - Task 7

Description:
The goal of this research task was to synthesize all existing documentation of best management practices and techniques for snow and ice control on gravel roads. A survey was distributed to all state-aid cities and counties in Minnesota and LTAP centers nationwide. These findings were synthesized into a PowerPoint presentation for training purposes to local agencies.

This presentation was developed to assist local governments with training for winter training maintenance on aggregate roads. Text only, participant handout with questions and room for notes.

Conclusions:
Recognizing the need to assist local governments with winter maintenance on aggregate roads, the LRRB's Research Implementation Committee developed a new training workshop. The workshop is targeted to maintenance personnel. The materials include PowerPoint slides with instructors notes (2003-23), and a participant workbook (2003-39).This presentation was developed to assist local governments with training for winter maintenance on aggregate roads. Text only, participant handout with questions and room for notes.

Activities: None noted

Report Located At:
Snow and Ice Control on Gravel Roads - Instructor 2003-23
http://www.lrrb.gen.mn.us/powerpoint/200323%20Instructor.ppt

Snow and Ice Control on Gravel Roads - Participant 2003-39
http://www.lrrb.gen.mn.us/powerpoint/200339%20Participant.ppt

Report #2004-18

Principal Investigator:
Michael Marti,
SRF Consulting Group, Inc.

Implementation Coordinator:
Lou Tasa,
Mn/DOT, State Aid District 2

Implementation Liaison:
Ann McLellan

Contract:
81424 (2002-036I)

Contract Period:
March 15, 2001
to February 27, 2004

Completed:
July 24, 2004

Funding:
$40,000
LRRB

Program:
2001-2002 RIC
INV 645

Tool Kit for a Career in Civil Engineering - Task 14

Description:
This CD-ROM kit contains a video, an FAQ document, a PowerPoint presentation and a brochure, all containing information on careers in civil engineering. The kit is especially directed toward high school students and was designed for use in school presentations on how to pursue careers in civil engineering.

Conclusions:
This tool kit was designed for use in school presentations, and contains information for high school students on how to pursue a career as a civil engineer or civil engineering technician. The kit contains a video, an FAQ document, a PowerPoint presentation and a brochure, all on one convenient CD-ROM. The video and PowerPoint presentation give an overview of how to prepare for a civil engineering career while in high school, and list several schools in the region that offer civil engineering or civil engineering technician degrees. The FAQ document aids in answering students' questions, and the brochure may be disseminated at high schools or career fairs. This project addresses the future workforce shortage in civil engineering by presenting civil engineering careers as meaningful and satisfying and offering good job opportunities and salaries.

Activities:
In August of 2005, a survey was sent out to people who received the Toolkit. The results were presented to the Research Implementation Committee and Mike Marti presented at the May 24th , 2006 CTS Transportation Research Conference. "Technology Exchange" from CTS at the University of Minnesota had an article titled "Meeting the Workforce Shortage: You Can Make a Difference" in the Summer 2004 Vol. 12, No. 3 edition. Web story on the LRRB website on the "Toolkit for a Career in Civil Engineering: You Can Make a Difference".

Report Located At:
Tool Kit for a Career in Civil Engineering 2004-18
http://www.lrrb.org/CE_Toolkit/

Work Force Shortage Brochure NONE11

Work Force Shortage FAQ NONE12

Contact the Mn/DOT Library at 651/296-2354 for a copy of the Tool Kit.

Mn/DOT's Implementation Funding Program

FY2005

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Implementation Funding Program Projects

Contract 81655 WO 167
FY 05 Program
Principal Investigator:
Joseph Labuz,
University of Minnesota

Technical Liaison:
Dan Sauve,
Clearwater County

Administrative Liaison:
Clark Moe

Contract Period:
6/30/2005 to 9/29/2006
Funding:
$25,000 STIP & $42,000 LRRB

Ground Penetrating Radar Implementation - RIC Task 8

Description:
The objectives of this project are to: 1) Produce a brochure and/or CD describing the potential applications of GPR at addressing the state's highways, 2) Produce a survey to be administered to each of the state's nine MN/DOT districts to identify key problems that potentially can be solved with GPR, 3) Identify key project in each district, 4) Perform GPR surveys, 5) Present findings in each district, 6) Write a best practices manual for use of GPR.

Status: Work in progress

Contract 87106
FY 05 Program
Principal Investigator:
Mark Snyder, Concrete Pavements Organization

Technical Liaison:
Rebecca Embacher, formerly Mn/DOT, Office of Materials

Administrative Liaison:
Clark Moe

Contract Period:
11/12/2004 to 6/30/2005
Funding:
$24,960

Refinement and Validation of the Washington Hydraulic Fracture Testing Specification/Training

Description: The Contractor will develop a specification for using the hydraulic fracture test (HFT) as a screening tool for concrete coarse aggregate freeze-thaw durability, assemble and set up small and large chamber HFT equipment at the State's Office of Materials laboratory, write the data acquisition program for use with the State's existing Fourier analyzer equipment, train State personnel to use small and large hydraulic fracture chambers, calibrate the small and large hydraulic fracture chambers and document testing protocol and directions describing how the results obtained from both the small and large chambers shall be used to calibrate (if necessary) the small chamber's percent dilation model for use with the large chamber data.

Status: Final paper

Contract 87171
FY 05 Program
Principal Investigator:
American Engineering Testing, Incorporated

Technical Liaison:
Tom Burnham, Mn/DOT, Office of Materials

Administrative Liaison:
Clark Moe

Contract Period:
12/9/2004 to 7/31/2006

Funding:
$25,000

Minne-ALF Results Marketing/Evaluation

Description: The goals of this program are threefold: 1) to increase the recognition of past Minne-ALF results within Minnesota, thereby facilitating implementation of program test results to date; 2) to increase recognition of the Minne-ALF device outside of Minnesota towards the goal of attracting new research testing and external funding; and 3) to evaluate the success of marketing an accelerated load testing device such as the Minne-ALF.

Status: Work in progress

No Deliverable

Principal Investigator:
Jim Grothaus, CTS, University of Minnesota

Implementation Coordinator:
Dan Gullickson, Mn/DOT, Office of Environmental Services

Implementation Liaison:
Jim Klessig and Clark Moe

Contract:
81655 WO 181

Contract Period:
6/25/2005 to 7/31/2006

Funding:
$25,000 STIP

Program:
FY2005 Mn/DOT's Implementation Funding Program

Train the Trainer Workshop for Blowing Snow Control

Description:
Blowing and drifting snow on Minnesota's roadways is a transportation efficiency and safety concern. The purpose for this research is to provide information to the Mn/DOT designers to deploy blowing and drifting snow control measures such as proper grading, structural snow fences and living snow fences in order to minimize the negative impacts blowing and drifting snow can have Minnesota's economy and on the well being of its citizens.

Conclusions:
Roadway designers will be updated to use "state of the art" technology to help eliminate snow drifts from forming along Minnesota Roadways. Benefits for implementing proactive, preventative flowing and drifting snow control measure will improve public safety, reduce snow removal and road maintenance costs, and provide economic benefits in travel time saved. Participants who attend this workshop will be encouraged to bring information to their communities and act as a local resource.

Activities:
"Blowing Snow Control Workshop" was held May 2-3, 2006 at the Mn/DOT Training and Conference Center in St. Cloud, Minnesota.

Implementation Funding Program Projects

Contract # 88487

FY 05 Program

Principal Investigator:
Brett Troyer
Technical Liaison:
Dwayne Stenlund,
Mn/DOT, Office of Environmental Services
Administrative Liaison:
Clark Moe, Mn/DOT
Contract Period:
8/11/2005 to 7/31/2006
Funding:
$11,808.31 STIP

Erosion Control in Roadside Ditches Preliminary Design Standards

Description:
Chief among the environmental issues facing erosion control systems designers are erosion control on slopes and surface water pollution in conveyance systems both during construction and operation of roadway facilities. Contract will review Best Management Practices and assist with improving erosion control selection processes.

Status: Work in progress

Report # 2006-13

Principal Investigator:
CNA Consulting Engineers, Incorporated

Implementation Coordinator:
John Siekmeier, Mn/DOT, Office of Materials

Implementation Liaison:
Clark Moe

Contract:
87203

Contract Period:
4/22/2005 to 6/30/2006

Funding:
$24,938.55 STIP

Program:
FY2005 Mn/DOT's Implementation Funding Program

Intelligent Compaction and In-Situ Testing at Mn/DOT TH53

Description:
Perform field testing and provide a report that documents the field demonstrations and validation of the wireless Light-Weight Deflectometer (LWD).

Conclusions:
This report describes an intelligent compaction demonstration project on Mn/DOT TH 53 in Duluth, MN, and the associated field and laboratory testing. The project was conducted during September 2005, using a Caterpillar Model CS-563E vibratory soil compactor, equipped with Intelligent Compaction (both Compaction Meter Value (CMV) and energy or power) and global positioning system (GPS) technology. A Prima LWD, dynamic cone penetrometer (DCP) and Humboldt GeoGauge were used to collect in situ companion test data at 42 locations. Mn/DOT conducted gradation, moisture content and Procter tests. Location and CMV were downloaded for comparison with the in situ testing. CMV data was compared to the in situ data on a point-by-point basis and on the basis of the overall distribution. In general, poor correlations were obtained on a point-by-point basis, likely due to the depth and stress dependency of soil modulus, and the heterogeneity of the soils. Good correlations were obtained between CMV values and DCP measurements for depths between 8-inches and 16-inches deep. The Caterpillar Compaction Viewer software, although still in development at the time of testing, is functional and is well integrated with GPS. It is easy to extract data and do more sophisticated analyses. Surface-covering documentation adds value by identifying potential problem areas where compaction is limited by material, moisture or subgrade deficiencies. LWD testing protocol must be followed to obtain useful results, since measurements vary significantly between successive tests. Relatively good correlations were obtained between LWD and GeoGauge. The GPS technology used for the demonstration is not adequate to distinguish between lifts.

Activities: None noted

Report Located At: http://www.lrrb.org/pdf/200613.pdf

Report # 2006-02

Principal Investigator:
Craig Churchward, HTNB Corporation

Implementation Coordinator:
Kristi Billiar, Mn/DOT, Office of Transit

Implementation Liaison:
Clark Moe

Contract:
88238

Contract Period:
7/26/2005 to 12/30/2005

Funding:
$25,000 STIP

Program:
FY2005 Mn/DOT's Implementation Funding Program

Bike and Pedestrian Implementation Toolbox

Description:
This Bicycle and Pedestrian Toolbox is a synthesis of current research on bicycle and pedestrian planning and facilities providing transportation planners and engineers with information on how to plan and design a bicycle and pedestrian network for a community.

Conclusions:
This Bicycle and Pedestrian Toolbox provides transportation planners and engineers with information on how to plan and design a bicycle and pedestrian network for a community. This toolbox summarizes each stage involved in the process of designing an active transportation network with a focus on how land use effects transportation planning. The planning is a cyclical six-stage process where first, community values are determined; second, existing features are evaluated; third, desire lines are identified; fourth, phasing of development is defined; fifth, selecting design treatments; and finally, sixth, evaluation of the network based on performance criteria.

Activities:
Outreach session on Accommodating Bike Riding was held on 6/7/06 in District 2. There were about 25 participants plus 10 others from the DOT, DNR and the State Bicycle Advisory committee.

Lou Tasa is sharing the information (PowerPoint and Toolbox) with the RDS's in his district and the City/County Engineers.

Report Located At: http://www.lrrb.org/pdf/200602.pdf

Report # 2006-24

Principal Investigator:
Gary Barnes, University of Minnesota

Implementation Coordinator:
Linda Zemotel, Mn/DOT, Office of Investment Management

Implementation Liaison:
Jim Klessig

Contract:
81655 WO 147

Contract Period:
11/19/2004 to 11/30/05

Funding:
$24,800 STIP

Program:
FY2005 Mn/DOT's Implementation Funding Program

Developing a Simple System for Public Involvement Conflict Management

Description:
There are two objectives: 1) to further understand and refine the conflict management framework through additional case studies and feedback from public involvement practitioners; and 2) to incorporate the conflict management framework into Mn/DOT's written public involvement guidelines as well as presentations and training sessions.

Conclusions:
This report describes a project to develop a simple system for managing conflict in transportation project public involvement. This work was focused on finding simple methods for managing less challenging projects and was aimed toward those who may do public involvement only occasionally. The conflict management framework is derived from a distillation of expert opinion, based on discussions of specific projects by Minnesota transportation public involvement experts. The framework is comprised of two components. The first is a simple organizational scheme for categorizing conflict to assist in determining the appropriate management strategy. The second part is the management strategies themselves. Key among these are principles for managing stakeholder relations so as to preclude the occurrence of conflict to the extent possible.

Activities:
Gary Barnes presented the project findings at the CTS Annual Research Conference in April 26, 2005.

Report Located At: http://www.lrrb.org/pdf/200624.pdf

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Mn/DOT's Implementation Funding Program

FY2003

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Guidelines for Superpave Level One Mix Design at the Local Government Level	353

Report # P2004-01

Principal Investigator:
Iris Charvat, University of Minnesota

Implementation Coordinator:
Bob Jacobson, Mn/DOT, Office of Environmental Services

Implementation Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 46

Contract Period:
6/9/2003 to 9/30/2004

Funding:
$25,000 STIP

Program:
FY2003 Mn/DOT's Implementation Funding Program

Production of Beneficial Mycorrhizal Inoculum

Description:
Prairie restorations are often conducted on sites that have been severely disturbed and lack a viable population of mycorrhizal fungi. The lack of fungal propagules and subsequent lack of mycorrhizal symbiosis are believed to result in reduced productivity of native species at restoration sites. By adding arbuscular mycorrhizal fungal (AMF) inoculum, vegetation managers will be able to plant newly established areas with prairie species and restore the health and vigor of these communities.

Conclusions:
The aim of this research is to produce a local, diverse mycorrhizal inoculum for commercial production for use in the Minneapolis/St. Paul area. In earlier studies, spores of several AMF species were isolated from a Minnesota remnant prairie and identified by morphological features. For each species, single spore cultures were established and stored in the cold for 6 to 7 years. Objectives of this project were to produce pot cultures from the single spore cultures and to recommend AMF species for commercial production. To check the identity of the fungi before and after inoculum production, genetic identification of fungi used to develop the inoculum should be performed. The extraction and preservation of DNA of AMF species were done. DNA analysis showed general agreement between the morphological and molecular identification of the spores and their placement in genera. However, results suggested that some species placement might not be consistent where these comparisons can be made. Further research may result in the re-naming of some species. Several AMF species are recommended as candidates for commercial inoculum production based on production of spores in pot cultures, on their longevity in cold storage, and in some species on molecular traits.

Activities: None noted

Report Located At: Contact the Mn/DOT Library at 651/296-2385 to check out the report.

No Deliverable

Principal Investigator:
Panos Michalopoulos, University of Minnesota

Implementation Coordinator:
Linda Taylor, Mn/DOT, currently Office of Maintenance

Implementation Liaison:
Clark Moe, Mn/DOT

Contract:
81655 WO 74

Contract Period:
5/27/2003 to 4/30/2004

Funding:
$15,600 STIP

Program:
FY2003 Mn/DOT's Implementation Funding Program

TRAMLAB Software, Training, and Support

Description:
Adapt previously developed Traffic Management Laboratory methodologies and tools for traffic modeling and simulation.

This is direct implementation from the project "Employment of the Traffic Management Laboratory (TRAMLAB) for Evaluating Ramp Control Strategies - Phase I" Report #2003-06.

Conclusions: N/A

Activities:
Training sessions were held for approximately 30 people on January 22 and 23, 2004. Report outlining streamlining and automation of modeling and the training session curriculum were posted on Traffic Engineering's Web site under modeling.

Report Located At: No final report

No Deliverable

Principal Investigator:
University of Maryland's BEST Center

Implementation Coordinator:
Erik Wolhowe, Mn/DOT, Office of Bridges

Implementation Liaison:
Clark Moe, Mn/DOT

Contract:
84649

Contract Period:
Not Listed

Funding:
$11,500 STIP

Program:
FY2003 Mn/DOT's Implementation Funding Program

DESCUS Training for Live Load Stresses in Steel Curved Girder Bridges

Description:
This project will develop guidelines that will determine when to use the DESCUS bridge software or when to use the BSDI software. A second implementation effort will be to provide training for the DESCUS software usage. This training will be through the University of Maryland's BEST Center.

No Deliverable

Principal Investigator:
Purdue University

Implementation Coordinator:
Bill Zerfas, formerly Mn/DOT, Office of Materials

Implementation Liaison:
Clark Moe, Mn/DOT

Contract:
85045

Contract Period:
9/5/2003 to 12/30/2003

Funding:
$12,499 STIP

Program:
FY2003 Mn/DOT's Implementation Funding Program

Guidelines for Superpave Level One Mix Design at the Local Government Level

Description:
Project will summarize the Superpave mix design and create guidelines for using Superpave mixtures on low volume roads. The guidelines will include a comparison to the 2350 specifications and provide recommendations about how and when to use each mixture. It will also develop guidelines and a training package for using gyratory (Superpave) mixtures on low volume roads at the local government level.

Conclusions: N/A

Activities:
Principal Investigator gave a PowerPoint Presentation of the project objectives to MAPA on December 2, 2003.

Report Located At: N/A

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Mn/DOT's Implementation Funding Program

FY2002

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Video # VT SB761.P742002

Principal Investigator:
N/A

Implementation Coordinator:
Paul Walvatne, Mn/DOT, Office of Environmental Services

Implementation Liaison:
Ann McLellan, Mn/DOT

Contract:
None
(2001-034I)

Contract Period:
N/A

Funding:
$5,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Implementation of Research Findings on Stem Girdling Roots of Trees Through Production of a Video for Technology Transfer

Description:
"Preventing Stem Girdling Roots" video explains how to plant trees properly to avoid stem girdling roots. SGR is an urban forest health epidemic, but is a predictable and fully preventable disease. Placing the root system at the proper height can prevent trees from dying prematurely as a direct consequence of stem girdling roots and buried root systems. Video presented by the Minnesota Society of Arboriculture.

Conclusions: N/A

Activities:
Approximately 40 videos were distributed to Mn/DOT landscape project inspectors, the Office of Environmental Services, Technical Support foresters and landscape architects, and a few Mn/DOT maintenance workers. A copy was also given to the Minnesota Park and Recreation Board and a Tree Care Advisor for the State of Minnesota.

Video Located At: VT SB761.P742002 located in the Mn/DOT Library

Funding Provided by:
U.S. Forest Service
Minnesota Department of Natural Resources
Minnesota Department of Transportation
Minnesota Turf & Grounds Foundation
Bailey Foundation
Living Sculpture Tree Care, Inc.
Minnesota Nursery & Landscape Association

Cooperation and Technical Advisement Provided by:
Bailey Nurseries, Inc.
Bachman's, Inc.
Top Notch TreeCare
Law's Nursery, Inc.
Margolis Col, Inc.
Minnesota Department of Agriculture
University of Minnesota
"A Practitioner's Guide to Stem Girdling Roots of Trees" Johnson and Hauer—2000

Web Site

Principal Investigator:
Mark Seeley, University of Minnesota

Implementation Coordinator:
Dan Gullickson, Mn/DOT, Office of Environmental Services

Implementation Liaison:
Jim Klessig, Mn/DOT

Contract:
81655 WO 24 (2001-035I)

Contract Period:
11/12/2001 to 9/30/2002

Funding:
$17,200 STIP
$13,000 Minnesota Agriculture Experiment Station

Program:
FY2002 Mn/DOT's Implementation Funding Program

Implementation of Climatological Summaries for Snow Fence Design Training & Development

Description:
Site-specific methods for the design and deployment of living snow fences were developed by Dr. Ronald Tabler (1994, 1997). Under contract with Mn/DOT (74708, Work Order 117) the University developed the climatological database and parameterizations to fully utilize Tabler's approach in designing living snow fences to mitigate effects of drifting snow. This database allows users to maximize the spatial resolution of climatological information and parameterizations in the design of snow fences. In the guidebook, "Catching the Snow with Living Snow Fences", steps are identified for designing living snow fences. This project will utilize the database and web site from the previous project as a supplement to the guidebook and to augment training of Mn/DOT personnel. The supplement will include instructions on utilizing the web site with the Tabler methodologies, illustrated by case studies. A major training session will be conducted with this in mind.

Conclusions:
A web site was designed and training sessions were given.

Activities:
Mark Seeley of the University of Minnesota and Dan Gullickson of Mn/DOT were chosen to receive the 2003 Research Partnership Award for their work on Living Snow Fence research and implementation.

Training sessions were held April 23 & 30, 2002 for a full day each.

Web site Located At: http://www.dot.state.mn.us/environment/livingsnowfence/index.html

Related Projects:
Contract 74708 WO 177 "Climatological Characterization of Snowfall an Snow Drift in Minnesota (for the Design of Living Snow Fences)" CD numbered NONE06

No Deliverable

Principal Investigator:
Dan Peterson, Mn/DOT, Alexandria Technical Center

Implementation Coordinator:
Jerry Miller, Mn/DOT, Assistant District Engineer Construction

Implementation Liaison:
Ann McLellan, Mn/DOT

Contract:
None
(2001-036I)

Contract Period:
N/A

Funding:
$19,915 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Identification of Prohibited Noxious Weeds along State Highway Right-of-Ways

Description:
Through a partnership with Alexandria Technical College, GIS Student Interns will use GPS equipment and GIS mapping to identify and inventory noxious weed infestations within right-of-ways.

Conclusions:
None noted.

Activities:
Presentation entitled "GPS Innovations" by Shannon Landon and Dan Peterson scheduled for the 2002 Vegetation Management Conference July 29-August 1, 2002 in Bloomington, MN.

Report Located At: N/A

Report #2004-39

Principal Investigator:
Joseph Labuz, University of Minnesota

Implementation Coordinator:
John Siekmeier, Mn/DOT, Office of Materials

Implementation Liaison:
Barb Loida, Mn/DOT

Contract:
81655 WO 32 (2001-037I)

Contract Period:
4/15/2003 to 9/30/2004

Funding:
$25,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Resilient Modulus Testing for MnPave

Description:
Provide material parameters for the implementation of MnPAVE. A series of laboratory tests will be conducted that will allow Mn/DOT to verify and improve the correlations currently used to estimate resilient modulus.

Conclusions:
Resilient modulus, shear strength, dielectric permittivity, and shear and compressional wave speed values were determined for 36 soil specimens created from the six soil samples. These values show that the soils had larger stiffnesses at low moisture contents. It was also noted during testing that some non-uniformity was present within the axial displacement measurements; larger levels of non-uniformity were associated with low moisture contents, possibly due to more heterogeneous moisture distributions within these specimens. Lastly, the data collected during this study was used to recommend a relationship between granular materials' small strain modulus and their resilient modulus. This relationship was given in the form of a hyperbolic model that accurately represents the strain-dependent modulus reduction of the base and subgrade materials. This model will enable field instruments that test at small strains to estimate the resilient modulus of soil layers placed during construction.

Activities: None noted

Report Located At: http://www.lrrb.org/pdf/200439.pdf

Related Projects:
Contract 74708 WO 185 "Enhancements and Verification Tests for Portable Deflectometers" Report 2003-10

"Moisture Effects on DCP and PFWD Measurements - Phase I" funded by the Center for Transportation Studies

Contract 81655 WO 57 "Moisture Effects on PVD and DCP Measurements" Report #2006-26

Web Site

Principal Investigator:
Michael Max, Environmentor Systems

Implementation Coordinator:
Todd Carroll, Mn/DOT, Office of Technical Support

Implementation Liaison:
Jim Klessig, Mn/DOT

Contract:
82265
(2001-038I)

Contract Period:
8/23/2001 to 2/28/2002

Funding:
$25,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Mn/DOT Interactive Multimedia Roadside Plant Selection Program, Phase IV-Completion & Implementation of Web Based "Expert System"

Description:
Implement the "expert system" with a web-based browser program to make it more widely available on the internet/intranet.

Conclusions:
The Plant Selector program was designed to help Mn/DOT designers and our other State, County and City partners make the best choices for roadside planting. This program also is great for professional and novice gardeners to easily select suitable plants for a number of conditions and scenarios. Are overhead wires present? Is there a concern regarding allergies to flowering plants? Do you have sandy soils? With a few simple clicks you can view a list of plants that will work in your conditions. You can print plant lists and download detailed fact sheets for each plant.

Activities: None noted

Web Site Located At: http://plantselector.dot.state.mn.us/

Related Projects:
Contract 75149 "Interactive Multimedia Roadside Plant Selection Matrix (IMPSM) Program Development"

Contract 77040 "Expanded Interactive, Multimedia CD-ROM Expert System for Roadside Plant Selection"

Internal Report

Principal Investigator:
Alfred Gardiner, Braun Intertec Corporation

Implementation Coordinator:
Erik Wolhowe, Mn/DOT, Office of Bridges

Implementation Liaison:
Ann McLellan, Mn/DOT

Contract:
None
(2001-039I)

Contract Period:
N/A
(Completed August 2003)

Funding:
$25,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Continuation of Evaluation for Chloride Penetration & Corrosion Inhibitor Admixture

Description:
In 1986, a new concrete admixture product was being marketed as a chemical additive capable of inhibiting the corrosion of reinforcing steel. As a test of the performance of the admixture, Mn/DOT placed a low-slump concrete overlay mix containing the admixture on the two west bound lanes of the Randolf Street bridge over I-35E. A traditional overlay mix was placed on the east bound lanes to serve as a control section. A monitoring system was installed and readings were taken each year until 1991 when it was decided that much more time was needed for the chemicals to migrate and reach concentration levels high enough to cause corrosion.

The performance tests done from 1986 through 1991 will be done again. The data will be collected and added to the data collected by the admixture industry last year so that a summary report can be written. Data will be collected from the Randolf Street bridge and from any other bridges which received the special overlay and were subsequently monitored.

Conclusions:
The report was not a typical research project, but rather, a report aimed at advising Mn/DOT on the performance of a particular vendor's product.

Activities:
N/A

Report Located At:
For questions, contact Erik Wolhowe at 651/747-2147 or erik.wolhowe@dot.state.mn.us

Wireless Modems for Mobile Computing Applications in Surveying Report

Principal Investigator:
N/A

Implementation Coordinator:
John Barke, Mn/DOT, Office of Land Management

Implementation Liaison:
Ann McLellan, Mn/DOT

Contract:
No Contract (2001-040I)

Contract Period:
N/A (Completed September 2002)

Funding:
$9,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Wireless Modems for Mobile Computing Applications in Surveying

Description:
In order to perform their assigned duties, Mn/DOT Geodetic field survey crews must have access to the geodetic survey point database, be able to communicate with each other, and be able to contact their supervisor. They must also report to the St. Paul office to report their bi-weekly time sheets, fill in their expense reports, and to pick up and drop off work results.

The Geodetic Surveys Unit proposes to purchase wireless modems and wireless service along with portable computers. All, or nearly all, communication among the field crews and between the field crews and their supervisors will take place using the proposed technology.

Activities:
A Power Point presentation was given at the Mn/DOT Survey Technical Conference in March 2002.

Report Located At:
Contact John Barke at 651/296-8804 for a copy of the report.

No Deliverable

Principal Investigator:
N/A

Implementation Coordinator:
Andrew Halverson, Formerly, Office of Technical Support

Implementation Liaison:
Jim Klessig, Mn/DOT

Contract:
None
(2001-041I)

Contract Period:
N/A

Funding:
$15,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Basic Elements of Roadside Safety Design

Description:
In order to inform designers of the state-of-the-art in roadside safety, it is desirable to hold a training session to familiarize the new and intermediate level designers with the most recent developments with respect to design guidelines, design standards and roadside safety hardware and to explain how these developments are to be incorporated in the preparation of road design plans.

No Deliverable

Principal Investigator:
N/A

Implementation Coordinator:
Erik Wolhowe, Mn/DOT, Office of Bridges

Implementation Liaison:
Jim Klessig, Mn/DOT

Contract:
None
2001-042I

Contract Period:
N/A

Funding:
$17,000 STIP

Program:
FY2002 Mn/DOT's Implementation Funding Program

Remote Monitoring of Distortional Fatigue in Multi-Girder Steel Bridges

Description:
This project will consist of purchasing the necessary equipment and training such that the two Mn/DOT Fatigue Inspection Crews will be able to incorporate the testing into their regular fatigue inspection program. The project will include:

1. Purchase electronic scientific testing equipment and accompanying training.
2. Training on techniques and procedures for installing test gages.
3. Education on methods for interpreting data and preparing effective repair plans.

Related Projects:
Contract 74708 WO 94 "Remote Monitoring of Distortional Fatigue in Multi-Girder Steel Bridges"

Contract 74708 WO 18 "Monitoring and Assessment Program for (Mn/DOT Bridge No. 79000) at Wabasha over the Mississippi River Phase I"

Contract 74708 WO 171 "Phase 2 - Analysis Tools and Rapid Screening Data for Distortional Fatigue in Steel Bridge Girders"

Contract 81655 WO 14 "Phase 3 - Rapid Assessment of and Decision-Making Strategies for Distortional Fatigue in Multi-Girder Steel Bridges"

Contract 81655 WO 120 "Rapid Assessment and Decision Making Strategies for Distortional Fatigue Multi-Girder Steel Bridges - Phase 4"

Mn/DOT's Implementation Funding Program

FY2001

Title	Page #
Implementation of Roundabout Research	366

No Deliverable

Principal Investigator:
N/A

Implementation Coordinator:
Ron Erickson, formerly Mn/DOT, Office of Technical Support

Implementation Liaison:
Ann McLellan

Contract:
No Contract
(2000-040I)

Contract Period:
N/A

Funding:
$22,000 STIP

Program:
FY2001 Mn/DOT's Implementation Funding Program

Implementation of Roundabout Research

Description:
A course notebook was put together by the RIC and Mn/DOT on the design of roundabouts, under the direction of Kittleson and Associates. The notebook was a collaboration of many sources including best practices internationally, research in the United States, adaptation to United States standard practices, and the judgment of the authors and reviewers. Two courses were given using the handbook, one in November 2000 and one in May 2001. The course instructors were consultants from Kittleson and Associates who also developed the Federal Highway Administration's "Roundabouts: An Informational Guide" Number FHWA-RD-00-067 for roundabout design (available through the Mn/DOT library or at www.tfhrc.gov/safety/00068.htm).

Conclusions:
A brief summary of the November 2000 course and the notification of the May 2001 course were listed in University of Minnesota's "Minnesota Technology Exchange" January - March, 2001 edition. The "Modern Roundabouts Planning and Design" course is also listed in the Technical Support Design Scene Chapter 9 - Plan and Profile; Roundabout section at www.dot.state.mn.us/tecsup/scene/chapters/scene_9.html. Also, direct mail was used to notify city and county engineers of the courses.

Activities:
Two courses were held in Minnesota; one during November 2000 and one during May 2001 entitled "Modern Roundabouts, Planning and Design". The total attendance consisted of 32 Mn/DOT personnel, 9 local government personnel, and 6 consultants.

Report Located At: N/A

Outcome: Knowledge gained

National Cooperative Highway Research Program

Project Number	Title	Mn/DOT Member	Approved Fiscal Year	Completion Date
D1711	NCHRP Project Panel on Recovery Area Distance Relationships	Julie Skallman, State Aid Division Director	1995	7/30/2004
D035505	NCHRP Project Panel on Capacity and Quality of service of Weaving Areas	Benjamin Osemenan, District Office	1997	12/10/2004
D0836	NCHRP Project Panel on Research for AASHTO Standing Committee on Planning: Support for Improved Transportation Planning and Project Development	Randy Halvorson, Program Management division Director	1999	12/31/2003
D2107	NCHRP Project Panel on Development of Portable Scour Monitoring Equipment	Andrea Hendrickson, Office of Bridges	2000	12/31/2002
D2522	NCHRP Project Panel on Technologies to Improve Consideration of Environmental Concerns in Transportation Decisions	Tim Quinn, Metro District	2000	6/9/2001
D1252	NCHRP Project Panel on LRFD Specifications for Horizontally Curved Steel Girder Highway Bridges	Kevin Western, Office of Bridges	2000	10/31/2005
D0362	NCHRP Project Panel on Guidelines for Accessible Pedestrian Signals (APS)	Beverly Farraher, Metro District	2002	11/30/2006
D0363	NCHRP Project Panel on Benefits of Freeway Monitoring Operations for Incident Response	Susan Groth, Office of Traffic, Security and Operations	2002	3/31/2004
D0518	NCHRP Project Panel on Color Effectiveness of Yellow Pavement Marking Materials	Jim McGraw, Office of Materials	2003	12/31/2006
D0615	NCHRP Project Panel on Testing and Calibration Methods for RWIS Sensors	Curt Pape, Office of Maintenance	2003	12/31/2005
D0842	NCHRP Project Panel on Rail-Freight Solutions to Roadway Congestion	Cecil Selness, Office of Freight and Commercial vehicle Operations	2003	9/30/2006

Gray shaded means project is completed

National Cooperative Highway Research Program

Project Number	Title	Mn/DOT Member	Approved Fiscal Year	Completion Date
D0937	NCHRP Project Panel on Using Surface Energy Measurements to Select Materials for Asphalt Pavements	Nancy Whiting, Office of Materials	2003	12/31/2006
D2527	NCHRP Project Panel on the Use and Effectiveness of Wildlife Crossing	Jason Alcott, Office of Environmental Services	2004	5/31/2007
D0714	NCHRP Project Panel on Guidelines for Cost-Benefit Analysis of Investment in Bicycle Facilities	Darryl Anderson, Office of Transit	2004	8/21/2005
D2064	NCHRP Project Panel on XML Standard for Exchange of Transportation Data (Trans-XML)	Todd Bergland, Office of Technical Support	2004	10/1/2006
D0849	Procedure for Transportation Planning, Programming and Preconstruction	Tim Henkel, Metro District	2004	9/30/2006
D1263	NCHRP Project Panel on Legal Truck Load and AASHTO Legal Loads for Posting	Lowell Johnson, Office of Bridges	2004	8/30/2006
D0848	NCHRP Project Panel on Using American Community Survey Data for Transportation Planning	Jonette Kreideweis, Office of Transportation Data and Analysis	2004	8/6/2005
D202434	NCHRP Project Panel on Commuting in America II	Jonette Kreideweis, Office of Transportation Data and Analysis	2004	9/30/2005
D0715	NCHRP Project Panel on Cost Effective Measures and Planning Procedures for Travel Time Variation, Delay and Reliability	Mark Larson, Office of Investment Management	2004	1/30/2006
D2523	NCHRP Project Panel on Environmental Information Management and Decision Support System for Transportation	Linda Zemotel, Office of Investment Management	2004	11/30/2006
D0141	NCHRP Project Panel on Models for Predicting Reflection Cracking of Hot Mix Asphalt Concrete Overlays	Bruce Chadbourn, Office of Materials	2005	5/2/2007
D1812	NCHRP Project Panel on Self-consolidation Concrete for Precast, Prestressed Concrete Bridge Elements	Jim Kochsiek, Office of Materials	2005	8/2/2007

National Cooperative Highway Research Program

Project Number	Title	Mn/DOT Member	Approved Fiscal Year	Completion Date
D0716	NCHRP Project Panel on Recommended Revisions to the AASHTO Guidelines for Traffic Data Programs	Jonette Kreideweis, Office of Transportation Data and Analysis	2005	3/28/2007
D0855	NCHRP Project Panel on Real Estate Data Integration for Project Delivery (Synthesis)	Kevin Leonard, Office of Land Management	2005	10/31/2006
D1528	NCHRP Project Panel to Modernize and Upgrade Cande for Analysis and LRFD Design of Buried Culverts	Erik Wolhowe, Office of Bridges	2005	10/28/2007
D1532	Effectiveness of Context Sensitive Design and Solutions in Transportation Facilities	Scott Bradley, Office of Technical Support	2006	5/24/2008
D2059	NCHRP Project Panel on Surface Transportation Security Research	Mark Wikelius, Drive to Excellence Director	2002	On-going
D1533	NCHRP Project Panel on the AASHTO Guide for Transportation Landscape and Environmental Design	Scott Bradley, Office of Technical Support	2006	5/14/2008
D0142	NCHRP Project Panel on Top-down Fatigue Cracking of Hot Mix Asphalt Layers	Shongtao Dai, Office of Materials	2006	4/30/2008
D0930A	NCHRP Project Panel on Rutting Performance Models for HMA and Structural Design	Shongtao Dai, Office of Materials	2006	11/28/2008
D2068	NCHRP Project Panel on the U.S. Domestic Scan Program	Randy Halvorson, Program Management Division Director	2006	4/19/2008
D0940	NCHRP Project Panel on Optimization of Tack Coat for HMA Pavements	Roger Olson, Office of Materials	2006	1/31/2008
D205923	NCHRP Project Panel on A Guide to Emergency Response Planning for Transportation	Mark Wikelius, Office of Maintenance	2006	Not Available

National Cooperative Highway Research Program

Project Number	Title	Mn/DOT Member	Approved Fiscal Year	Completion Date
DA0303	NCHRP Project Panel on Assessing the Impacts of Incompatible Land Uses Near Airports	Raymond Rought, Office of Aeronautics	2006	Not Available
D0857	NCHRP Project Panel on Framework and Tools for Highway Pricing Decisions	Kenneth Buckeye, Office of Investment Management	2007	8/6/2008
D1071	NCHRP Project Panel on Evaluation of CIP Reinforced Joints for Full-Depth Precast Bridge Decks	Daniel Dorgan, Office of Bridges	2007	11/4/2009
D0943	NCHRP Project Panel on Mix Design Practices for warm Mix Asphalt	Tim Clyne, Office of Materials	2007	Not Available
D0860	NCHRP Project Panel on Risk Management Manual for Methods and Tools to Control Project Cost Escalation	Tim Henkel, Metro District	2007	Not Available
D0862	NCHRP Project Panel on Implementing Transportation System Performance Management Programs-Insight from Practitioners	Mark Larson, Office of Investment Management	2007	Not Available
D2431	NCHRP Project Panel on AASHTO LRFD Design-Construction Specifications of Shallow Foundations for Highway and Bridge Structures	Richard Lamb, Office of Materials	2007	Not Available
D2109	NCHRP Project Panel on Intelligent Soil Compaction System	John Siekmeier, Office of Materials	2007	2/28/2009
D0863	NCHRP Project Panel on Review of Canadian and Mexican Experience with Large Commercial Motor Vehicles	Cecil Selness, Office of Freight and Commercial Vehicle Operations	2007	Not Available
D0711	NCHRP Project Panel on Customer Research Practices and Applications in Transportation	Chris McMahon, Office of Investment Management	2007	10/1/2007

Mn/DOT Research Selected Projects FY2007

Category	Proposal Number	Title	Funding	Panel
District	P2007019	Wetland Mitigation in Abandoned Gravel Pits	$54,783 Mn/DOT $54,782 BWSR	Kurt Johnson (U of M—Duluth); Robert Jacobson (Mn/DOT, Office of Environmental Services); Ann McLellan
Bridge	P2007024	Discrepancies in Shear Strength of Prestressed Beams with Different Specifications	$114,390 Mn/DOT	Catherine French (U of M); Lowell Johnson (Mn/DOT, Office of Bridges); Nelson Cruz
Bridge	P2007131	Corrosion Protection Performance of Epoxy-Coated Reinforcing Bars	$59,288 Mn/DOT	Jose Pincheira (U of W– Madison); Paul Rowekamp (Mn/DOT, Office of Bridges); Ann McLellan
Environmental Services	P2007126	The Utility of Wildlife Crossings in Minnesota	$54,561 Mn/DOT	Brock McMillian (Minnesota State University—Mankato); Jason Alcott (Mn/DOT, Office of Environmental Services); Ann McLellan
Environmental Services	P2007059	Methodology to Incorporate Historic/Prehistoric Surface hydrology Layer in Mn/Model Using Existing GIS Data	$54,046 Mn/DOT	Stacey Stark (UMD); Beth Hobbs (Mn/DOT); Nelson Cruz
Investment Management	P2007029	Growth of Property Values Near Major Transportation Corridors	$50,000 Mn/DOT	Gary Barnes (U of M); Rabinder Bains (Mn/DOT, Office of Investment Management); Dan Warzala
Land Management	P2007010	An Inventory of the Public Land Survey Records for Minnesota	$38,290 Mn/DOT	Rod Squires (U of M); Jay Krafthefer (Mn/DOT, Office of Land Management); Sandy McCully
Maintenance	P2007103	LED Lighting for Snow Plows and Related Maintenance and Construction Vehicles	$25,502 Mn/DOT	Timothy Vogt (St. Cloud State University); Linda Taylor (Mn/DOT, Office of Maintenance); Sue Lodahl
Pavement and Materials	P2007077	Revision of the MnROAD Offline Data Peak-Picking Program	$48,345 Mn/DOT	Ahmed Tewfik (U of M); Tom Burnham (Mn/DOT, Office of Materials); Nelson Cruz
Security	P2007054	Responding to the Unexpected: Development of a Dynamic Data-Driven Traffic Operation Model for Effective Evacuation	$150,000 Mn/DOT	Henry Liu (U of M); Sonia Morphew (Mn/DOT, Office Homeland Security); Cory Johnson
Technical Support & Metro Design	P2007035	Safety Effectiveness of Narrow Paved Shoulders: Deployment Strategies to Reduce Lane Departure Crashes and Fatalities	$67,886 Mn/DOT	Craig Shankwitz (U of M); Jim Rosenow (Mn/DOT, Office of Technical Support); Shirlee Sherkow

Mn/DOT Research Selected Projects FY2007

Category	Proposal Number	Title	Funding	Panel
Technical Support & Metro Design	P2007105	Evaluation of the Effects of Centerline Rumble Strips on Non-Conventional Vehicles	$22,568 Mn/DOT	Kenneth Miller (St. Cloud State University); Dave Engstrom (Mn/DOT, Office of Traffic, Security and Operations); Dan Warzala
Traffic and Opera-tions	P2007052	Development of a Platoon-Priority Control Strategy and Smart Advance Warning Flashers for Isolated Intersections with High-Speed Approaches	$70,000 Mn/DOT	Henry Liu (U of M); Susan Zarling (Mn/DOT, Office of Traffic, Security and Opera-tions); Cory Johnson
Transit, Bikeways and Pe-destrians	P2007028	Impact of Bicycle Facilities on Commute Mode Share	$50,000 Mn/DOT	Gary Barnes (U of M); Darryl Anderson (Mn/DOT, Office of Transit); Dan Warzala
Transit, Bikeways and Pe-destrians	P2007014	Using Archived ITS Data To Improve Transit Performance and Management	$38,500 Mn/DOT	Ahmed El-Geneidy (U of M); Micky Gutzman (Mn/DOT, Office of Transit); Nelson Cruz
Transpor-tation Data Analysis	P2007079	Development of Data Warehouse and Applications for Continuous Vehicle Class and Weigh-in-Motion (WIM) Data	$91,388 Mn/DOT	Taek Kwon (U of M-Duluth); George Cepress (Mn/DOT, Office of Transportation Data and Analysis); Nelson Cruz
Transpor-tation Data Analysis	P2007139	Feasibility of Statewide Travel Demand Model	$75,000 Mn/DOT	Amiy Varma (North Dakota State University); Gene Hicks (Mn/DOT, Transportation Data and Analysis); Nelson Cruz
Access to Destina-tions	P2007080	How Close is Close Enough? Estimating Accurate Distance Decay Functions for Different Purposes and Multiple Modes	$55,510 Mn/DOT	Kevin Krizek (U of M); Cindy Carlsson (Office of Investment Management); Jim Klessig
Access to Destina-tions	P2007005	Access to Destinations: Monitoring Land Use Activity Changes in the Twin Cities Metropolitan Region	$88,000 Mn/DOT	David Levinson (U of M); Rabinder Bains (Mn/DOT, Office of Investment Management), Rob Luckow (Hennepin County); Jim Klessig
Access to Destina-tions	N/A	Parcel Level Land Data Acquisition & Analysis for Measuring Non-Auto Accessibility	$85,000 Mn/DOT	Kevin Krizek (U of M); Rabinder Bains (Mn/DOT, Office of Investment Management), Rob Luckow (Hennepin County); Jim Klessig
Other	N/A	History of Minnesota Highways	$50,000 Mn/DOT	Bob Johns (U of M, Center for Transportation Studies); Chuck Siggerud (SHE, Incorporated); Sue Lodahl

LRRB Selected Projects for CY2006

INV Number	Title	Funding	Panel
839	Warrants for Roundabouts	$39,988 LRRB	Shauna Hallmark (Iowa State University); Roger Gustafson (Carver County); Clark Moe
840	Performance of PG 52-34 Oil thru CY08	$76,200 LRRB	Shongtao Dai (Mn/DOT, Office of Materials); Brian Noetzelman (Pope County); Dan Warzala
841	Long-Term Maintenance Effect on Hot Mix Asphalts Pavements Caused by Centerline Edge-Line, Shoulders, and Stop Bar Rumble Strips	$43,257 LRRB	Tom Wood (Mn/DOT, Office of Materials); Dennis Luebbe, (Rice County); Dan Warzala
842	Best Practices for Dust Control on Aggregate Surfaced Roads	$75,000 LRRB	Eddie Johnson (Mn/DOT, Office of Materials); John McDonald (Faribault County); Clark Moe
843	Predicting the Occurrence of Bumps in Overlays	$64,540 LRRB	Jim Wilde (Minnesota State University—Mankato); John Brunkhorst (McLeod County); Clark Moe
844	Update of Vehicle Classification for County Road Pavement Design	$94,516 LRRB	Jim Wilde (Minnesota State University—Mankato); Tim Stahl (Jackson County); Clark Moe
845	Documentation of Crash Characteristics and Safety Strategies at Horizontal Curves on Rural Highways	$70,373 LRRB	Craig Shankwitz (U of M); Nathan Richman (Waseca County); Shirlee Sherkow
846	Hydraulic, Mechanical, and Leaching Characteristics of Recycled Materials	$135,000 LRRB	Satish Gupta (U of M); Ruth Roberson (Mn/DOT, Office of Materials); Nelson Cruz
847	Use of Fly Ash for Reconstruction of Bituminous Roads	$170,056 LRRB	Paul Bloom (U of M); Fred Salsbury (City of Waseca); Clark Moe
848	Warning Efficacy of Active Passive Warnings for Unsignalized Intersection and Mid-Block Pedestrian Cross-Walks	$119,000 LRRB	Thomas Smith (U of M); Deb Bloom (City of Roseville); Dan Warzala
849	Study of Environmental Effects of De-icing Salt on Water Quality in Minnesota	$94,000 LRRB	Heinz Stefan (U of M); Wayne Sandberg (Washington County); Ann McLellan
850	Mechanistic Modeling of Dynamic Cone Penetrometer Test	$105,000 LRRB	Kimberly Hill (U of M); Lee Amundson (Lincoln County); Nelson Cruz

LRRB Selected Projects for CY2006

INV Number	Title	Funding	Panel
851	Allowable Axle Loads on Pavements	$110,000 LRRB	Lev Khazanovich (U of M); Maureen Jensen (Mn/DOT, Office of Materials); Clark Moe
852	Subsurface Drainage Manual for Pavements in Minnesota	$71,638 LRRB	John Nieber (U of M); Dan Sauve (Clearwater County); Clark Moe
853	Development of Flexural Vibration Inspection Equipment and Techniques to Rapidly Assess the Structural Health of Rural Bridge Systems: Phase II	$52,980 LRRB	Brian Brashaw (U of M—Duluth); Chris Morris (St. Louis County); Ann McLellan
854	Pavement Performance/Failure under Overweight Farm Loads	$110,000 LRRB ($365,000 Other funding)	Shongtao Dai (Mn/DOT, Office of Materials); Rick Kjonaas (Mn/DOT, State Aid); Jim Klessig
855	A Property-Based Specification for Coarse Aggregate in Pavement Applications	$32,775 LRRB $32,775 Mn/DOT	Magdy Abdelrahman (North Dakota State University); Gary Bruggeman (Steele County); Dan Warzala
856	Investigation of In-Place Asphalt Film Thickness and Performance of Minnesota Hot Mix Asphalt Mixtures	$39,000 LRRB $39,000 Mn/DOT	Mihai Marasteanu (U of M); Shongtao Dai (Mn/DOT, Office of Materials); Dan Warzala
857	A Report and Analysis of Effects of Seasonal and Climatic Changes on Ride Quality as Observed in MnROAD Low Volume Roads	$39,750 LRRB $39,750 Mn/DOT	Lev Khazanovich (U of M); Ben Worel (Mn/DOT, Office of Materials); Cory Johnson
858	Crack and Concrete Deck Sealant Performance	$37,500 LRRB $37,500 Mn/DOT	Arturo Schultz (U of M); Gary Peterson (Mn/DOT, Office of Bridges); Nelson Cruz
859	Toward the Next Generation of Traffic Counting and Prediction Methods. Phase I: Model Identification and Validation	$55,000 LRRB	Gary Davis (U of M); Rick Kjonaas (Mn/DOT, State Aid); Cory Johnson
860	Compaction Specifications for Unbound Materials	$105,000 LRRB	John Siekmeier (Mn/DOT, Office of Materials); Larry Berkland (Steele County); Shirlee Sherkow
861	Best Management Practices for Pavement Preservation of Hot Mix Asphalt	$71,050 LRRB	Tom Wood (Mn/DOT, Office of Materials); Tim Stahl (Jackson County); Ann McLellan

LRRB Selected Projects for CY2006

INV Number	Title	Funding	Panel
862	Development of a Real-Time Arterial Performance Monitoring System Using Traffic Data Available from Existing Signal Systems	$70,000 LRRB $70,000 ITS	Henry Liu (U of M); Eric Drager (Hennepin County); Shirlee Sherkow
863	Optimal Timing of Preventative Maintenance for Addressing Environmental Aging in HMA Pavements (MnROAD)	$75,000 LRRB $260,000 Pooled Fund	Tom Wood (Mn/DOT, Office of Materials); Jim Klessig
864	Recycled Asphalt Pavements (MnROAD)	$75,000 LRRB $275,000 Pooled Fund	Roger Olson (Mn/DOT, Office of Materials); Jim Klessig
865	Investigation of Low Temperature Cracking in Asphalt—Phase II (MnROAD)	$100,000 LRRB $300,000 Pooled Fund	Ben Worel (Mn/DOT, Office of Materials); Jim Klessig
866	Recycled Unbound Pavement Materials	$75,000 LRRB $450,000 Pooled Fund	Eddie Johnson (Mn/DOT, Office of Materials); Jim Klessig

Mn/DOT's Implementation Funding Program Selected Projects for FY07 (May)

Title	Funding	Panel
Portable Field Moisture Technology	$35,000 Mn/DOT	John Siekmeier (Mn/DOT, Office of Materials); Ruth Roberson (Mn/DOT, Office of Materials)
Promoting the Bicycle and Pedestrian Toolbox	$25,000 Mn/DOT	Mary Jackson (Mn/DOT, Office of Transit)
Refinement and Validation of the Washington Hydraulic Fracture Testing Specification/Training	$35,000 Mn/DOT	Bernard Izevbekhai (Mn/DOT, Office of Materials)
Roundabouts (DVD and Educational Materials)	$75,000 Mn/DOT—State Aid, RIC	Jim Rosenow (Mn/DOT, Office of Technical Support), Rick Kjonaas (Mn/DOT, State Aid), Paul Stine (Mn/DOT, State Aid)
Best Practices: Managing and Enhancing Roadside Vegetation for Desirable Wildlife	$35,000 Mn/DOT $12,500 LRRB/ RIC	Paul Walvatne (Mn/DOT, Office of Environmental Services)
Enhanced Coordination of Cadastral Information: Opportunities to Improve Mn/DOT and Local Government Collaboration	$30,000 LRRB/ RIC $51,500 Seeking FHWA	Rick Morey (Mn/DOT, Office of Land Management); Rick Kjonaas (Mn/DOT, State Aid); Jay Krafthefer (Mn/DOT, Office of Land Management)

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