

MnROAD



*Safer, Smarter, Sustainable Pavements
Through
Innovative Research*

October 2011

Additional Partners

Applied Research Associates
Bloom Consultants, LLC
Case Western Reserve University
CRREL (Cold Regions Research Environmental Lab)
Danish Road Institute
Finnish Transport Agency
Michigan Technological University
Minnesota Pollution Control Agency
Minnesota State University – Mankato
National Center for Asphalt Technology
National Resources Research Institute
Norwegian Public Roads Administration
Swedish Transport Administration
Texas Transportation Institute
University of California Pavement Research Center
University of Illinois at Urbana- Champaign
University of Pittsburgh
University of Wisconsin
Transportation Research Board (TRB)
US Department of Energy
US Environmental Protection Agency
Western Research Institute



**MnROAD Site
9011 77th Street NE
Monticello, Minnesota 55362
www.mndot.gov/mnroad**

**For Further Information Contact
Maureen Jensen
Maureen.Jensen@state.mn.us
Phone (651) 366- 5507**

Welcome to MnROAD!

MnROAD, located near Albertville, Minnesota (40 miles northwest of the Twin Cities) is a cold region testing facility and laboratory operated by the Minnesota Department of Transportation (MnDOT) is unique to the world. MnROAD consists of two road segments that are divided into over 50 test cells, each representing various combinations of road-building materials and designs:

- Mainline (ML) 3.5-mile Interstate-94 roadway
- Low Volume Road (LVR) 2.5-mile roadway that uses a controlled 5-axle semi tractor-trailer

MnROAD was originally constructed in 1994 at a cost of \$25 million provided by state and federal funding. The partnership between Minnesota Department of Transportation (MnDOT) and the Minnesota Local Road Research Board (LRRB) provided the majority of MnROAD operational funding during the first ten years. Over the years, researchers from around the nation, and the world, have utilized the MnROAD facility and data.



MnROAD enables researchers to:

- Evaluate pavement performance under real, physical conditions (traffic, environment, materials).
- Examine the way factors such as moisture, frost, traffic loading, construction, and materials interact through the use of an extensive instrumentation network.
- Design customized experiments supporting specific researcher needs that utilize the experienced MnROAD research staff and its equipment.
- Provide a safe work zone for testing because of its unique ability to remove traffic without disruption to the driving public.
- Develop tools and methods based on actual performance data to improve the design, construction, and maintenance of pavements.



Successes and Benefits

Serving the Nation

Nationally, MnROAD has played a key role in: 1) Supporting several NCHRP studies, including the development of the next generation pavement design guide, 2) providing a location with a wide range of surface characteristics to study noise, smoothness, and safety and 3) developing and field validating intelligent transportation systems (ITS).

Minnesota Initiatives

Results from Phase I research (1994-2006) at MnROAD have made positive impacts within the state of Minnesota and the nation at large. Increases in performance and pavement life have resulted in a reduction in costs for maintenance, repairs, user delays and congestion. Six MnROAD studies (indicated in the table below) are estimated to have saved Minnesota \$33 million and a potential \$749 million nationally each year. It is expected that the results of Phase II will be similarly beneficial.

Phase I (MN) Implemented Research	Annual Savings
Spring Load Restriction Policy	\$14 Million
Winter Load Increase Policy	\$7 Million
Low Temperature Cracking Reduction	\$5.7 Million
ME Flexible Design Method	\$4 Million
ME Rigid Design Method	\$1.2 Million
Sealing Pavement/ Shoulder Joints	\$1.2 Million

Local Initiatives

The mission of the LRRB is to serve local, city and county engineers through the development of new initiatives, the acquisition and application of new knowledge, and the exploration and implementation of new technologies. LRRB funding of MnROAD supports research to improve local road design, construction, maintenance and better environmental practices.

We perform several services for the LRRB which are best categorized into these areas: 1) Providing technical support for LVR operations, 2) providing field support for pavement preservation, maintenance & rehabilitation, 3) assisting with waste product utilization including shingles, glass, fly ash, recycled PCC, and HMA, and 4) following-up and implementing completed research.



Transportation Engineering & Road Research Alliance

TERRA's Mission Statement

"To develop, sustain and communicate a comprehensive program of research on pavement, materials, and related transportation engineering challenges including issues related to cold climates"

TERRA Members

Government

Iowa Department of Transportation
Michigan Department of Transportation
Minnesota Department of Transportation
Minnesota Local Road Research Board
New York State Department of Transportation
North Dakota Department of Transportation
Norwegian Public Roads Administration
United States Federal Highway Administration
Wisconsin Department of Transportation

Industry

Aggregate and Ready Mix Association of Minnesota
American Concrete Pavement Association
American Traffic Safety Services Association – Northland Chapter
Associated General Contractors of Minnesota
Caterpillar Global Paving
Concrete Paving Association of Minnesota
Mathy Technology and Engineering Services
Minnesota Asphalt Pavement Association
RMC Research & Education Foundation
Road Science, LLC

Academic

Iowa State University
Michigan Technological University
University of Minnesota

TERRA is a road research governance structure that partners private industry and academia with national, state, and local road authorities.

TERRA exists to:

Expand entrepreneurial use of the MnROAD facility by pursuing opportunities that will serve the broader research community.

Create productive research partnerships.

Provide effective transportation engineering and road research.

Communicate effectively transportation engineering and road research activities, benefits, and results.

MnROAD test cells are designed around studies developed by our partners which represent local, state, national and international interests. The cells include both new construction and rehabilitation along with various asphalt and concrete pavement surfaces.

Construction of Phase II test cells began in 2007 and continued with projects in 2008, 2010 and 2011. Almost 40 test cells were reconstructed on the Low Volume Road and Mainline representing over 20 different research projects. Listed below are the five research aims during Phase II:

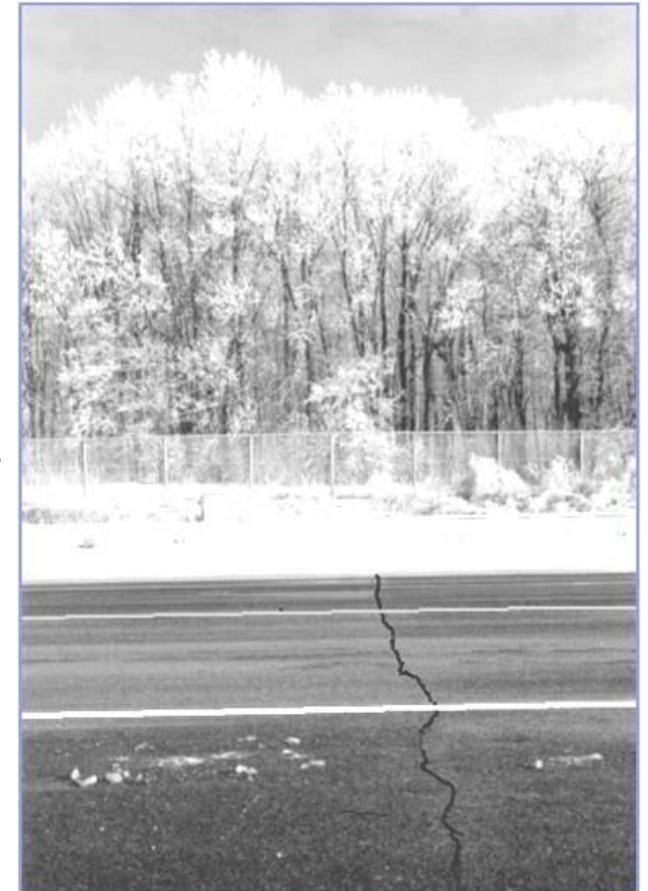
Innovative Construction – Team with industry and academia to implement new technology, materials, and construction methods that maximize productivity and reduce user delays.

Green Roads – Reduce dependence on virgin materials throughout the pavement structure by reusing pavement materials and various waste products including taconite aggregates, fly ash, shingles, Recycled Asphalt Pavement, and other materials. Also, to more efficiently design pavement based on today's technology.

Preservation and Rapid Renewal – Develop and improve techniques to maintain and rehabilitate our current pavement investments, reduce life cycle costs, and maximize investments for long term performance.

Surface Characteristics – Establish new techniques with our research partners for smooth, quiet, durable, and safe skid-resistant pavements.

Non-Pavement Research – Continue supporting traffic, environmental, industrial, and intelligent transportation systems through the use of MnROAD's unique facility.



Phase II Composite Studies



<p>SHRP II R21 Composite Pavement Study Applied Research Associates is incorporating sustainable technologies in long-lasting, low maintenance pavements.</p>
<p>TPF-5 (165) Development of Design Guide for Thin and Ultrathin Concrete Overlays of Existing Asphalt Pavements (MS, MN, MO, NY, PA) University of Pittsburgh is developing a rational design method for whitetopping.</p>
<p>TPF-5 (149) Design and Construction Guidelines for Thermally Insulated Concrete Pavements (CA, MN, WA, FHWA, LRRB) University of Minnesota is developing design and construction guidelines for thermally insulated concrete pavements.</p>
<p>Unbonded Concrete Overlay Using PASSRC and Unwoven Geotextiles (CPAM, ACPA, MnDOT) MnDOT is supporting industry initiatives to find the best-performing interlayer material for stress relief and drainage in UBOL design.</p>

Phase II Farm Equipment Study

TPF-5 (149) The Effects of Implements of Husbandry “Farm Equipment” on Pavement Performance
(MN, LRRB, IA, IL, WI, PNAAW)
University of Minnesota is investigating the effects of heavy farm equipment on the stress and strain behavior of county roads.



Phase II Base & Aggregate Studies

<p>TPF-5 (129) Recycled Unbound Pavement Materials (CA, MI, MN, OH, TX, WI) University of Wisconsin’s study of the strength, deformation, and material performance of recycled aggregate base applications.</p>
<p>The Use of Taconite Aggregates in Pavement Applications (NRRI, MnDOT) MnDOT’s study to learn the suitability of waste rock from Minnesota’s Iron Range for use in pavement applications.</p>
<p>Full Depth Reclamation Stabilized with Engineered Emulsion (Road Science, LLC, MnDOT) MnDOT’s study of the structural design and field performance of stabilized full-depth reclamation layers.</p>



Field Investigation of Highway Base Material Stabilized with High Carbon Fly Ash
(Bloom Consultants, U of WI, MPCA)
MnDOT’s evaluation of the physical and environmental properties of base materials stabilized with high carbon fly ash in comparison to recycled pavement materials and crushed stone.

Development of New Open Graded Base Specification
(MnDOT, FHWA)
MnDOT development a new OGAB specification that is both permeable and stable under construction traffic.

Pooled Fund Research
Visit www.pooledfund.org or the MnROAD web site, www.mndot.gov/mnroad/projects, for more information.

Phase II Concrete Studies

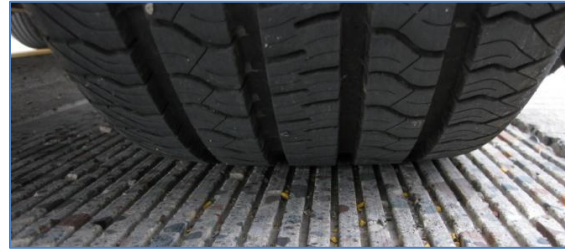
TPF-5 (134) PCC Surface Characteristics – Diamond Grinding

(MN, TX, IGGA, ACPA, FHWA)

MnDOT and Minnesota State University's study of the effect of the full-scale deployment of innovative diamond grind concrete surface for optimized noise, friction, and ride quality.

Investigation of High Performance Concrete Pavement

MnDOT's development of an improved service life prediction model for current 60-year concrete designs while understanding the behavior in regards to maturity, slab warp and curl, and thermal expansion.



Pervious Concrete Pavement Study

(LRRB, MnDOT)

MnDOT's study of permeability, freeze thaw durability, and maintenance activities at MnROAD and on city streets.

PCC Surface Characteristics – Construction

(MnDOT, FHWA)

MnDOT's study to determine how surface characteristics of various textures on new concrete affect noise, friction, ride and other properties

Pervious Concrete Overlay Mix Design for Wearing Course Applications

(CTRE, MnDOT)

MnDOT's study of cracking, permeability, and ride performance of pervious concrete overlays.

Phase II Asphalt Studies



HMA Surface Characteristics related to Ride, Texture, Friction, Noise & Durability

(LRRB, MnDOT, FHWA)
MnDOT is measuring various surface characteristics over time to develop improved mix designs.

Recycled Asphalt Pavements

(LRRB, MnDOT, FHWA)

MnDOT is incorporating Recycled Asphalt Pavement and Shingles into asphalt mixtures and studying their effect on pavement durability.

Field Investigation of Polyphosphoric Acid Modified Asphalt

(Innophos, Marathon, Paragon, ICL, MTE, WRI, FHWA, MnDOT)

MnDOT is studying the effects of PPA binder modification in laboratory and field performance of modified asphalt mixtures.

TPF-5 (153) Optimal Timing of Preventative Maintenance for Addressing Environmental Aging in HMA Pavements

(MD, MN, OH, TX, LLRB)

The Asphalt Institute is taking a fresh approach to characterizing binder aging and its impact on the timing of surface treatments.

TPF-5 (132) Investigation of Low Temperature Cracking in Asphalt Pavements – Phase II

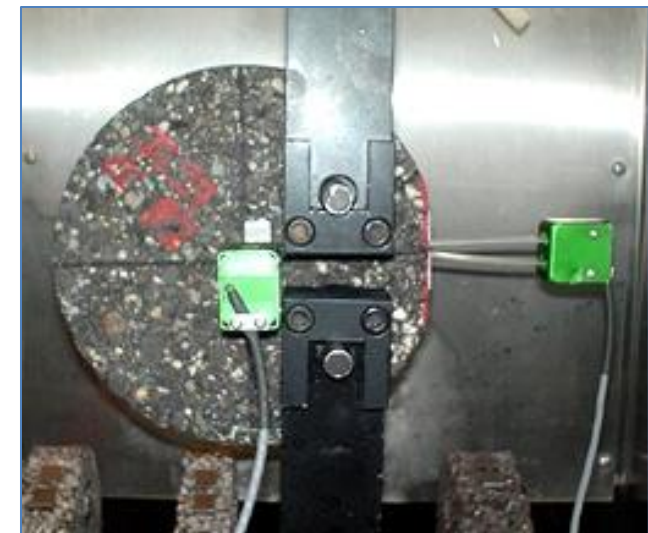
(CT, IA, MN, ND, NY, WI)

The University of Minnesota is developing Low Temperature Cracking mixture specifications based on laboratory fracture testing and modeling.

Permeable (HMA) Pavement Performance in Cold Regions

(LRRB, MnDOT)

MnDOT's study focusing on snow melt, permeability, layer stiffness, and other differences between porous and conventional HMA.

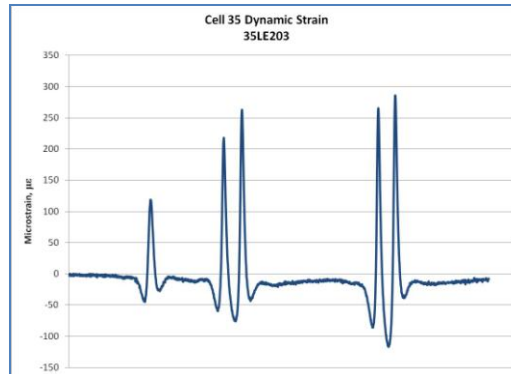


MnROAD Sensors

MnROAD has installed over 9500 sensors over the last 17 years. Each sensor type has unique testing frequencies and data handling procedures. These sensors are linked by fiber optics directly into the MnROAD's computerized data collection system and measure variables such as temperature, moisture, strain, deflection and frost depth, among others, in and under the pavement.

There are two different types of pavement sensors: static (environmental) and dynamic (forces applied by traffic). MnROAD also collects traffic data and has a weather station, on site.

The dynamic pavement response sensors, triggered by the passage of heavy vehicles, take readings up to 2000 times per second while the static sensors capture environmental data every 15 minutes.



Examples of sensor types:

Dynamic Sensors: LVDT, Concrete Embedment Strain Gauge, Steel Strain Gauge, Dynamic Soil Pressure Cell, and Bituminous Strain Gauge.

Static Sensors: Horizontal Clip Gauge, Moisture Gauge, Thermocouple, Resistivity Probe, Tipping Bucket, and Vibrating Wires.



Monitoring & Field Performance

MnROAD has been monitoring pavement performance since 1994 through laboratory testing, sensor response, and field monitoring over the life of each test cell. Each research project determines the specific testing and monitoring needed as part of the project's experimental design and work plan and once completed is entered to the database.

MnROAD Field Monitoring Data

MnROAD monitoring begins with the initial measurements after construction and follows the pavement performance throughout its life. Forensic studies are completed after the study's conclusion. MnROAD incorporates traditional field monitoring along with MnROAD developed field tools.

MnROAD Laboratory Testing Data

MnROAD and its partners, run both standard and experimental types of testing for subgrade, bound/unbound base materials, concrete, and asphalt surface materials.



MnROAD Database

This database allows MnROAD researchers to accurately record methodology and pertinent information for research use and requests.

All data and reports are available at no cost and are featured on the MnROAD website or by request. Certain information is stored offline requiring a request to MnROAD research staff.

www.mndot.gov/mnroad/data