

Serving the Nation

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



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Site Phone # (651) 297-2996
www.mndot.gov/mnroad

Become a Research Partner!

The Minnesota Department of Transportation is committed to producing timely cost-effective research findings that have a local, regional, and national impact on improving our transportation system. Please contact us to further discuss MnROAD and partnership opportunities available to you and your organization.

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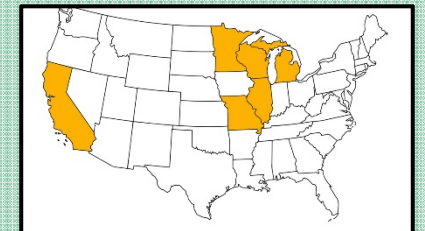
MnROAD

*Safer, Smarter, Sustainable Pavements
Through Innovative Research*



Supported by NRRRA Members and Associates
including Minnesota Local Road Research Board

May 2017



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) and is unique to the world. MnROAD consists of two road segments that are divided into ~50 test cells, each representing various combinations of road-building materials and designs:

- 3.5 mile Mainline (ML) Interstate-94 Westbound
- 3.5 mile Old Westbound Interstate-94 Westbound
- 2.5 mile Low Volume Road (LVR) that is loaded with a controlled 5-axle tractor-trailer

MnROAD was originally constructed in 1994 at a cost of \$25 million provided by state and federal funding. 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 use of an extensive instrumentation network.
- Design customized experiments supporting specific researcher needs that utilize 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 design, construction, and maintenance of pavements.

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 specific testing and monitoring needed as part of the project's experimental design and work plan, once completed is entered to the MnROAD oracle database.

MnROAD Field Monitoring Data

MnROAD monitoring begins with initial measurements after construction and follows 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 and are featured on the MnROAD website or by request. Certain information is stored offline requiring a request to MnROAD research staff.

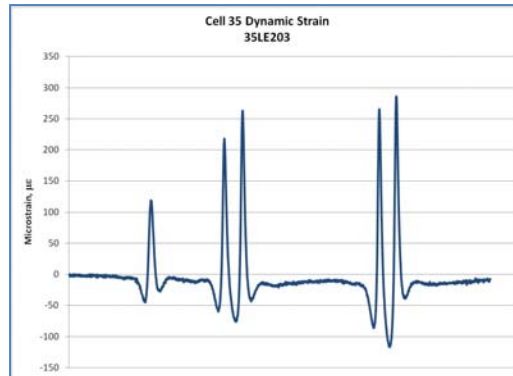
www.mndot.gov/mnroad/data

MnROAD Sensors

MnROAD has installed over 9500 sensors over the last 23 years. Each sensor type has unique testing frequencies and data handling procedures. These sensors are linked by fiber optics directly into 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.

Dynamic pavement response sensors, triggered by passage of heavy vehicles, take readings up to 2000 times per second while 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.



MnROAD Partnerships – Join us in our Efforts



National Road Research Alliance

The National Road Research Alliance (NRRRA) brings together governmental agencies, academia, and industry from around North America and internationally to drive innovation in primarily the field of pavement research with a heavy focus on implementation. By evaluating designs, materials, equipment, and processes collectively in real-world conditions, NRRRA will be able to foster the most effective techniques and technologies to save agencies money, improve safety and increase efficiency. The need for a national pooled fund study formed around the [2014 Peer Exchange](#), a gathering of national stakeholders that developed the initial structure the alliance. MnROAD currently is one of two active large scale pavement accelerated testing test tracks in the country. It studies both asphalt and concrete roadways and is located in a northern freeze/thaw environment. MnROAD has separate partnerships with NCAT. <http://www.dot.state.mn.us/mnroad/nrra/index.html>

Long Term Partnership with Minnesota Local Road Research Board

The mission of the LRRB is to serve local, city and county engineers through development of new initiatives, acquisition and application of new knowledge, and 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.

Successful Partnership with NCAT

MnDOT's MnROAD Research Facility Partnership with National Center for Asphalt Technology (NCAT)

Pooled Fund TPF-5(267) – <http://www.pooledfund.org/Details/Study/496/>
Alabama Lead State – MnDOT is a subcontractor to Auburn (NCAT)



MnROAD and NCAT have partnered on two studies beginning in 2015. The first project is to advance national pavement preservation technology through quantification of life-extending benefits. The second project addresses development and implementation of asphalt performance tests to predict cracking for common distress. This will enable engineers to select mixtures and assess mixture performance expectations before any mix is placed in the field during construction. Sharing resources and expertise will improve coordination of experiments, expand evaluation of pavement performance in both northern and southern climates, and provide cost-effective solutions that can be implemented nationwide. In 2016 both eight test sections were built at MnROAD and pavement preservation treatments have been placed on US-169 and CSAH-8 in Mille Lacs County. More details on this partnership - <http://www.dot.state.mn.us/mnroad/NCATpartnership/index.html>.

Phase I - (1994-2006) Research Successes and Benefits

Results from Phase I (1994-2006) 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. Related to Minnesota only (granted other states and organizations have also benefited) MnROAD studies are estimated to save \$33 million/year.

Phase I Research	Savings/yr
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

Phase I Full Report - <http://dotapp7.dot.state.mn.us/ResearchTracking/pdf/2008MRRDOC033.pdf>

Phase III – 2017 NRRA Long Term Research

Compacted Concrete Pavement (CCP) for Local Street--Industry has been successful in Michigan and Kansas using CCP paving for local streets. This could be an alternative to compete with traditional HMA pavements allowing paving with HMA pavers. This is a updated version of roller-compacted concrete with better finished surface characteristics.

Recycled Aggregates in Aggregate Base and Larger Subbase Materials--States continue to look for effective ways to recycle materials into unbound bases. This adds to MnROAD's understanding of recycled bases and what seasonal strength values may be used for advanced Mechanistic designs and how it is effected by size/gradation.

Optimizing the Mix Components for Contractors--What effect does low cement content mixes have on long-term performance and constructability? Two mixes will be studied to give agencies a better understanding if cost savings with less cement is something that may be done.



Maintaining Poor Pavements--Road owners have to do more with less funding to maintain their roadway system. What practices should be used for stabilizing both HMA and PCC roadways when accepted correct repair cannot be done due to funding levels?

Partial Depth Repair of Concrete Pavements--This is a part of a “state of practice” study also being done. This study will include up to 15 innovative materials--each one will use panels in common locations on MnROAD's old westbound to determine effectiveness and what new alternatives are available.

Phase III - 2017
 NRRRA Long Term Research

The Following are long term research efforts that are being pursued by NRRRA team members. These efforts will be done by leading consultants and Universities.



HMA Overlay and Rehab of Concrete and Methods of Enhancing Compaction
 States are looking for longer lasting HMA overlays of concrete. New mix designs were developed to promote long term performance of these mixes including how reflective cracking effects may be minimized though design or other joint treatment.



- Cold Central Plant Recycling**
 Other states have utilized RAP stockpiles into plant mix base coarse mixes (layers below the wear surface) to effectively recycle these materials in a controlled mix design. How may these layers best be utilized and what type of surface mix or chip seal maybe placed on top?
- Fiber Reinforced Concrete Pavements**
 Nationally states are wanting to get a better understanding of the beneficial use of fibers in concrete pavement layers. Is it worth its cost and how may it best be utilized in both thin city streets and highway roadways, both as new construction and rehabilitation.
- Early Opening Strength to Traffic**
 What effect does early traffic have on “uncured” concrete? Test sections will be loaded in one lane so early PCC ruts will be present and in the other lane long before most states typically allow it. We want to see what long term effect these loadings have on performance.

Phase – II (2007-2016) Research Successes and Benefits

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. Again 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. Related to Minnesota only (granted other states/organizations have also benefited) MnROAD studies are estimated to save 10.3 million/year.

Phase II Research	Savings/yr
Investigation of Low Temperature Cracking in Asphalt Pavements (Phase-II) - TPF-5(132)	\$2,273,000
Development of an Open Graded Aggregate Base (Stable and Drainable)	\$4,770,000
Thin and Ultrathin Concrete Overlays of Existing Asphalt Pavements - TPF-5(165)	1,927,00
Development of Design Guide for Recycled Unbound Pavement Materials - TPF-5(129)	829,000
Full-Depth Reclamation Stabilized with Engineered Emulsion	505,700
Field Investigation of Highway Base Material Stabilized With High Carbon Fly Ash	92,400



Phase II Full Report - <http://dotapp7.dot.state.mn.us/ResearchTracking/pdf/201519.pdf>

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

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.

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

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

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.

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.
http://www.dot.state.mn.us/mnroad/projects/HMA_Surf_Characteristics/index.html

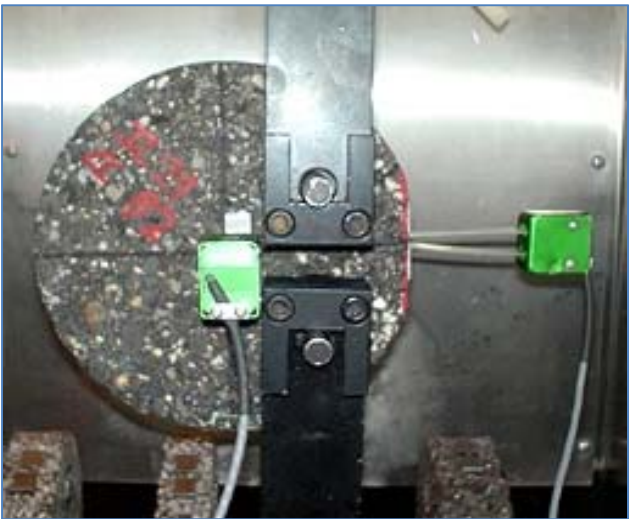
Recycled Asphalt Pavements (LRRB, MnDOT, FHWA)
MnDOT is incorporating Recycled Asphalt Pavement and Shingles into asphalt mixtures and studying their effect on pavement durability.
<http://www.dot.state.mn.us/mnroad/projects/RAP/index.html>

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.
http://www.dot.state.mn.us/mnroad/projects/Polyphosphoric_Acid_Mod_Aspalt/index.html

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.
http://www.dot.state.mn.us/mnroad/projects/Optimal_Timing/index.html

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.
http://www.dot.state.mn.us/mnroad/projects/Low_Temp_Cracking/index.html

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.



Phase III—2017 NRRRA Short Term Research Continued

Repair of Joint Associated Distress Pavement--Concrete joints are typically the greatest issue for concrete pavements – what is each state doing and how may best practices be shared to improve the performance of these pavements?

Larger Subbase Materials--Some states are utilizing strong base materials and others are not. How may we build and invest in better unbound bases and less into the concrete and asphalt above it?

Subgrade Design for New and Reconstructed—A common definition of subgrade is needed, including how these layers are developed during construction, compaction, and acceptance.



Surface Characteristics of Diamond Ground PCC Surfaces--Diamond grinding is being implemented by some states while others are struggling to utilize this rehabilitation technique.

Partial Depth Repairs of Concrete--This ties to a long term research effort but again each state is approaching partial depth repairs in different ways and some are reluctant to use this repair technique at all. Documentation of what is being done and technology transfer is needed in this area.

Pavement preservation approaches for lightly surfaced roadways--State and local agencies are working to do more with less and effectively maintaining “thinner” lower volume roadways is needed more than ever. NRRRA members want to develop a best practice from each of its members. Currently one does not exist.

Phase III National Road Research Alliance

NRRA was founded in 2016 to help enable MnROAD to gain greater benefits for the nation. The current structure of NRRA consists of an executive committee that provides oversight and overall direction and is supported by four technical teams that have membership from the states as well as the associate members. The Rigid, Flexible, Geotechnical, and Preventive Maintenance teams develop the prioritized technical needs for both long-term research efforts and short-term technology transfer. The last team is the Technology Transfer team--also formed with state and associate members who drive implementation efforts developed from the technical teams and approved by the executive committee.



Phase III—2017 NRRA Short Term Research

The Following are short term research efforts that are being pursued by NRRA team members. Other topics will be added once these 8 are completed.

Tack coats are not consistently utilized to bond each HMA layer together. How is each state approaching this issue, what specs do we have in common, and may be standardized?

Longitudinal Joint Construction Performance--what is being done and how may each state improve long term performance in this area?

Design and Performance of Concrete Unbonded Overlays--Concrete overlays are being utilized in some states and less in others. Tech transfer is needed to aid in this construction practice.

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 full-scale deployment of innovative diamond grind concrete surface for optimized noise, friction, and ride quality.

http://www.dot.state.mn.us/mnroad/projects/PCC_Rehab/index.html

Investigation of High Performance Concrete Pavement

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

http://www.dot.state.mn.us/mnroad/projects/High_Performance_PCC_Design/index.html



Pervious Concrete Pavement Study (LRRB, MnDOT)

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

http://www.dot.state.mn.us/mnroad/projects/Pervious_Conc_Pavement/index.html

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

http://www.dot.state.mn.us/mnroad/projects/PCC_Construction/index.html

Pervious Concrete Overlay Mix Design for Wearing Course Applications (CTRE, MnDOT)

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

http://www.dot.state.mn.us/mnroad/projects/Pervious_Concrete_Mix_Design/index.html

Phase II - “Composite Studies”



SHRP II R21 Composite Pavement Study

Applied Research Associates is incorporating sustainable technologies in long-lasting, low maintenance pavements.

http://www.dot.state.mn.us/mnroad/projects/Composite_Pavement_Systems/index.html

TPF-5 (165) Development of Design Guide for Thin and Ultrathin Concrete Overlays of Existing Asphalt Pavements (MS, MN, MO, NY, PA, TX)

University of Pittsburgh is developing a rational design method for whitetopping.

<http://www.dot.state.mn.us/mnroad/projects/Whitotopping/index.html>

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.

http://www.dot.state.mn.us/mnroad/projects/Composite_Pavement_Systems/index.html

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.



Phase II - “Farm Equipment Study”

TPF-5 (148) 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 stress and strain behavior of county roads.

http://www.dot.state.mn.us/mnroad/projects/Implements_of_Husbandry/index.html

Phase II – “Base & Aggregate Studies”

TPF-5 (129) Recycled Unbound Pavement Materials (CA, MI, MN, OH, TX, WI)

University of Wisconsin’s study of strength, deformation, and material performance of recycled aggregate bases.

http://www.dot.state.mn.us/mnroad/projects/Recycled_Unbound_Pavement_Materials/index.html

The Use of Taconite Aggregates in Pavement Applications (NRRI, MnDOT)

MnDOT’s study to learn suitability of waste rock from Minnesota’s Iron Range for use in pavement applications.

http://www.dot.state.mn.us/mnroad/projects/Taconite_Aggregates/index.html

Full Depth Reclamation Stabilized with Engineered Emulsion (Road Science, LLC, MnDOT)

MnDOT’s study of structural design and field performance of stabilized full-depth reclamation layers.

<http://www.lrrb.org/media/reports/201236.pdf>



Field Investigation of Highway Base Material Stabilized with High Carbon Fly Ash (Bloom Consultants, U of WI, MPCA)

MnDOT’s evaluation of physical and environmental properties of base materials stabilized with high carbon fly ash in comparison to recycled pavement materials and crushed stone.

http://www.dot.state.mn.us/mnroad/projects/High_Carbon_Fly_Ash/index.html

Development of New Open Graded Base Specification (MnDOT, FHWA)

MnDOT development of 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.