MnROAD and National Road Research Alliance
2023 North Central Regional Local Roads Conference
Sioux Falls, South Dakota October 2023

Benjamin Worel, P.E.(MN)
MnROAD Operations Engineer
NRRA Executive Director

DEPARTMENT OF TRANSPORTATION

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MnROAD and NRRA

Focus on the power of good people, quality data, and Partnership Opportunities

- **MnROAD Introduction**
- **MnROAD / NCAT Partnership**
- **National Road Research Alliance (NRRA)**

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MnROAD – why was it really built?

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MnROAD Early History

- **AASHO Road Test (1956-58 built – traffic loadings from 1958-60)**
- **Need for Local Calibrations**
  - MnDOT started Investigation 183 / Flexible Designs (Started 1960's)
  - SHRP/LTPP started for national efforts (8/8/1988)
  - Idea of a cold regions testing facility (1980's)
- **MnROAD Development**
  - Development of Support
    - Getting 25 million in 1990
  - Soil Foundation
  - Instrumentation
  - 1992 and 1993 Construction
  - August 2, 1994 Traffic

GRAND OPENING MnROAD AUGUST 2, 1994

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MnROAD Background

- **MnROAD Owned and Operated by Minnesota DOT**
  - **27 Dedicated Road Research Staff**
  - **10 MnROAD Staff**
- **HMA and PCC Research**
- **30 Years of Long-Term Customer Service**
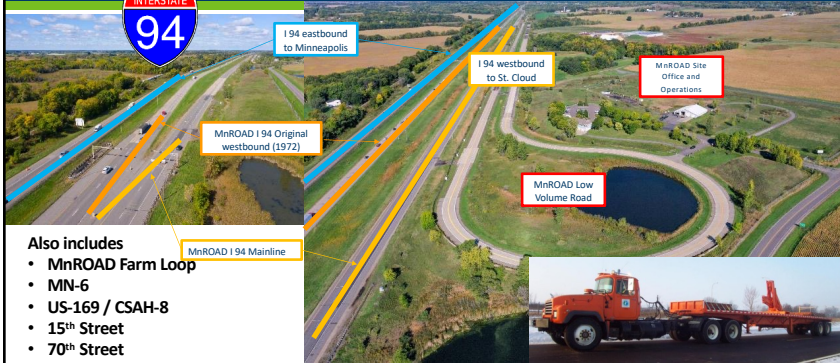 - Minnesota Department of Transportation (MnDOT)
  - Minnesota Local Road Research Board (LRRB)
  - National Partnerships (SHRP II / NCHRP / FHWA)
  - National Center of Asphalt Technology (NCAT)
  - National Road Research Alliance (NRRA)

NRRA
National Road Research Alliance

LRRB

National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

DEPARTMENT OF TRANSPORTATION

MnROAD
SAFER, SMARTER, SUSTAINABLE PAVEMENTS THROUGH INNOVATIVE RESEARCH

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MnROAD- Minnesota Road Research Facility

INTERSTATE 94

- I 94 eastbound to Minneapolis
- I 94 westbound to St. Cloud
- MnROAD Site Office and Operations
- MnROAD I 94 Original westbound (1972)
- MnROAD Low Volume Road
- MnROAD I 94 Mainline

Also includes
- **MnROAD Farm Loop**
- **MN-6**
- **US-169 / CSAH-8**
- **15th Street**
- **70th Street**
- **+ Others**

mndot.gov

Mack Tractor (93406) with Fruehauf Trailer (93410)

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MnROAD Performance Data

- **Performance Monitoring**
- **List is missing**
  - Albedo Measurements
  - Drone Videos
  - Road Doctor with GPR
  - Detailed Forensics
  - Rolling Weight Deflectometer
  - Rolling Density Meter
  - Many others
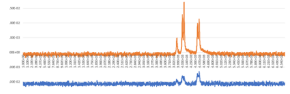
  - Working towards greater automation

  Each Data type has detailed information on the equipment and data collection used

Measurement	Frequency	Comment
Aging Samples	1 / year	Cores taken to monitor aging of HMA mix and PCC joint condition
Distress Survey	2 / year	Modified LTPP Survey on all cells
Dynamic Load Testing	4 / year	Dynamic load testing of sensors. Loading from MnROAD truck and FWD.
Joint Faulting/ Shoulder Dropoff	2 / year	Use an automated Georgia Faultmeter per modified LTPP protocol
Friction	1-2 / year	KJ Law profiler, grip tester and dynamic friction tester used
Falling Weight Deflectometer	8 / year	Testing schedule varies throughout the year. Routine and special testing on HMA and PCC.
HMA Rutting/ Crack Cupping	3 / year	Advanced Laser Profile System (ALPS) used to characterize rutting and crack cupping
Noise	3 / year	On Board Sound Intensity (OBSI) measurements and sound absorption
Piezometer	4 / year	Monitoring well measurements
Permeability	2-4 / year	Test permeability of pervious/porous test cells
Ride Quality	2-4 / year	Pathways and lightweight profiler
Sound Absorption	3 / year	Sound absorbtion measurements.
Surface Texture	1 / year	Sand Patch and Circular Texture Meter

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MnROAD Sensor Data

- **Sensors**
  - MnROAD Data Collection Network
  - ~15,000+ Sensors Installed
  - Static (every 15 min)
    - Temperature
    - Moisture
    - Joint Opening
    - Concrete Maturity
    - Environmental Stain
    - Pressure
    - Ground Water
    - Frost Depth

- Dynamic Data
  - Live Traffic Loading - Controlled Loading
  - Earth Pressure Cells
  - Pore-Water Pressure
  - Asphalt and Concrete Stains
  - Displacement

- 2 Weather Stations
- Traffic Data
  - 2022 Installing a new systems

Each Data type has detailed information on the equipment and data collection used

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Access to MnROAD Data

- **National Database**
  - MnROAD InfoPave
    - Non-LTPP / Tied to LTPP
    - NRRA funding
    - FHWA partnership
  - Allows users to:
    - Get a MnROAD overview
    - Find test sections
    - See available data
    - View Data
    - See Maps
    - Related Reports (working)
    - Download Data
    - Working on Sensors
  - New release soon

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MnROAD Key Projects

- Rigid Pavement – can build thinner
- Flexible Pavement – environment plays a key role
- Flexible – MnPAVE (Inputs into PavementME)
- Rigid – MnPAVE Rigid
- Concrete Overlay of Asphalt

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Low Temperature Cracking Initial Findings

- 1994 MnROAD Test Sections (PG 64-22, PG 58-28)

5-Year (PG 58-28) Thin

10-Year (PG 58-28) Thick

10-Year (PG 64-22) Thick

- 1999 LVR (PG 58-28, 58-34, 58-40)

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Seasonal Load Limits
Spring Restrictions / Winter Overloads

MnROAD Data/Models Statewide Implementation

MnDOT Website

Monitoring Sites Installed around the State

Spring Thaw

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Importance of Drainage

Asphalt
- Deterioration asphalt
- Increased roughness (ride)

Concrete
- ML Observations (high traffic)
  - <u>None</u> - PASB used
  - <u>Some</u> - Class-5 / well sealed joints / edge drain
  - <u>High amount</u> - Class-5 / no edge drains
- LVR Observations (low traffic)
  - If sealed class-5 is not as destructive
  - If not-sealed class-5 can develop joint damage

Benefits
- Importance of drainable bases / sealing
- Effect on ride

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MnROAD / NCAT Partnership

Formalized Partnership working on National Needs:
- Full scale accelerated test facilities
- North / South Climatic Zones / Sections
- CAPRI (NCAT Lead National HMA Consortium)

Cracking Group Experiments
- 6 year of partnership with 10 Government Agencies
- HMA cracking test for LTC and fatigue cracking

Additive Group Experiment
- NCAT focus on fatigue cracking
- MnROAD focus on Reflective Cracking
- Continued National Research Coordination

Preservation Group Experiments
- Life extending benefits of pavement preservation techniques
- 8 year of partnership with over 24+ agencies
- Developing next phase – starting in January 2024

MnROAD
SAFER, SMARTER, SUSTAINABLE PAVEMENTS THROUGH INNOVATIVE RESEARCH
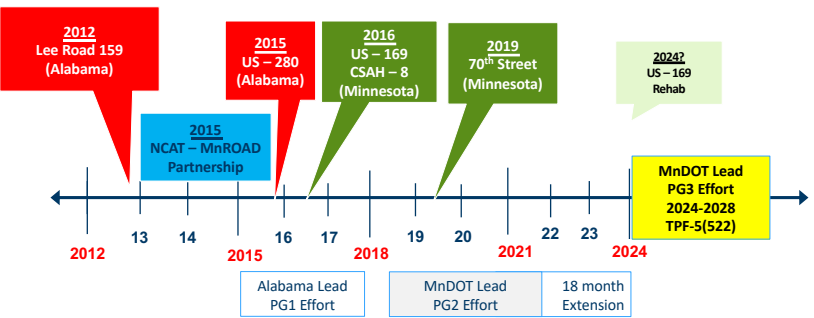
Foundation for Pavement Preservation

Industry members

FHWA

NCAT
National Center for Asphalt Technology
at AUBURN UNIVERSITY

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Preservation Group Study

2012 Lee Road 159 (Alabama)

2015 NCAT – MnROAD Partnership

2015 US – 280 (Alabama)

2016 US – 169 CSAH – 8 (Minnesota)

2019 70th Street (Minnesota)

2024? US – 169 Rehab

MnDOT Lead PG3 Effort 2024-2028 TPF-5(522)

2012   13   14   2015   16   17   2018   19   20   2021   22   23   2024

Alabama Lead PG1 Effort

MnDOT Lead PG2 Effort

18 month Extension

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NCAT/MnROAD Preservation Group (PG) Effort (Northern In-Place Recycling – 70th Street)

2019 Construction (Thinlays over)
- Control (no other work)
- SFDR (foam-emulsion)
- CIR (foam-emulsion)
- CCPR (foam-emulsion)
- 2 Regular Mill/Fills

2 Year Observations
- Ride (IRI)
  - 2019 IRI over 300 in/mi
  - 2021 IRI 60-100 in/mi
- Reflective Cracking
  - Difference in controls and recycled sections cracking
- Rutting – not an issue

1 Mile
16 Test Sections

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National Road Research Alliance Membership Overview

TPF-5(466) - Fee Structure / year (five years)
- **Phase-1 complete** (5 yr) **– Now into Phase-2** (year 2/5)
- **13 Full Agency Commitments (yellow)**
  - $75K /$150K Annual Commitment
  - 11 States, Illinois Tollway, LRRB
  - FHWA is also a contributing partner
- **2 ICT Commitments (Green)**
  - $25K (ICT Team only – Veta Efforts)
  - GA and NY
- **~85+ Associate membership**
  - 2K/year - Associations, Industry, Consultants, Universities
  - Upper Great Plains Transportation Institute
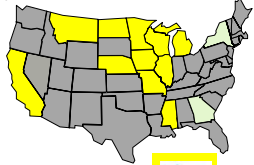
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National Road Research Alliance Overview

- **NRRA has averaged ~$1 million research/year**
- **NRRA Funded 48 projects (phase1) and 14+13 (phase2)**
  - Short and long term research
  - Multiple Researchers Contracted
- **2023 Call for Innovation ~$1.7 million**
  - 55 Proposals Received
  - 22 Proposals Prioritized by the Technical Teams
  - **13** Projects being funded (counted above)
    - TAP being developed
    - TAP finalize workplans
    - MnDOT contracting
- **2017 & 2022 MnDOT provided MnROAD construction funding**
- **2024 MnROAD is expecting on 1 million in mainline construction funding**

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National Road Research Alliance Overview

- **Organizational Structure**
  - Executive Committee (2 reps/agency)
  - 5 Technical Teams (agency and associate reps)
    - Technical Chairs
    - MnDOT Representative
  - MnROAD Facility Utilized

  - Outreach is done in the technical teams
    - Lauren Dao, MnDOT

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National Road Research Alliance (Flexible Technical Team Membership)

Caltrans	Michigan	Minnesota LRRB	Nebraska	Wisconsin
Kee Foo*	Andrew Bennet	James Foldesi*	Bruce Barrett*	Ali Arabzadeh*
Raghubar Shrestha*	Tyler Hunt		Lieska Halsey	Dan Kopacz*
	Kevin Kennedy	**Mississippi**	Wally Heyen	Tirupan Mandal
FHWA	Nathan Maack*	Heath Patterson*	Robert Rea	Ali Morovatdar
Peter Eakman		Griffin Sullivan*	Brandon Varilek	Barry Paye*
	Minnesota			
Illinois	Michael Vrtis, MnDOT	**Missouri**	**North Dakota**	
Brian Hill*	Ryan Baasen	Jason Blomberg*	Curt Dunn, chair	
James Trepanier	Emil Bautista	Paul Denkler	Andy Ayash	
Charles Wienrank*	Shongtao Dai*	Willie Johnson*	Amy Beise	
	John Garrity*	Dan Oesch	Brandon Bennes	
Illinois Tollway	Jerry Geib		Matt Kurle	
Jay Behnke*	Joseph Podolsky	**Montana**	Matt Linneman	
Ross Bentsen*	Dave Van Deusen	Josh Heck*	Arlen Norris	
John Lavallee		Oak Metcalfe*	Korby Seward	
	Ben Worel	Matt Needham	Tyler Wollmuth*	* indicates voting agency member
Iowa	Eyoab Zegeye Teshale			
Chris Brakke*				
Ashley Buss*				

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National Road Research Alliance
(Flexible Technical Team Associate Membership)

Mohiuddin Ahmad, University of Texas-El Paso (UTEP)
Riaz Ahmad, iENGINEERING Corporation
Allen Akowicz, Pacific Geosource
Edith Arambula, Texas A&M Transportation Institute
Jason Bausano, Ingevity
Thomas Bennert, Rutgers University
Jay Bianchini, Collaborative Aggregates
Justin Black, Cargill
Andrea Blanchette, Terracon
Brandon Brever, Minnesota Asphalt Pavement Association (MAPA)
Tom Brovold, Testquip
Bill Buttlar, University of Missouri - Columbia
Mike Byrnes, Mathy Construction Co.
Douglas Carlson, Liberty Tire Recycling
Eshan Dave, University of New Hampshire
Jonathan Davis, Uberbinder
Mohamed Elkashef, University of California Pavement Research Center
Amy Epps Martin, Texas A&M Transportation Institute
Rouzbeh Ghabchi, South Dakota State University
Oliver Giraldo-Londono, University of Missouri - Columbia
Stacy Glidden, Payne & Dolan
Jonathan Groeger, iENGINEERING Corporation
Elie Hajj, University of Nevada - Reno
Bill Hall, Resource Recycling Systems
Katie Hasslett, HRG Lab
Majeed Hayat, Marquette University
David J. Jones, University of California Pavement Research Center
Dennis Kelley, J. Rettenmaier USA LP
Lev Khazanovich, University of Pittsburgh
Candice Kohn, Pacific Geosource

Emin Kutay, Michigan State University
Brett Lambden, Husky Energy
Fabricio Leiva, Pacific Geosource
Chad Longcore, J. Rettenmaier USA LP
Rajib Mallick, UTEP
Todd Mansell, Caterpillar Paving Products
Mihai Marasteanu, University of Minnesota - Twin Cities
Ken Maser, Infrasense
Luke Meyer, Bio-Based Spray Systems
Danial Mirzaiyanrajeh, Solmax
Kiran Mohanraj, The Transtec Group
Pete Montenegro, Collaborative Aggregates
Raquel Moraes, NCAT
Chibuike Ogbo, Terracon
Eric Olson, Solmax
Brian Orr, BASF
Andrew Peterson, South Dakota State's Local Transportation Program
Hadi Rashidi, National Stone Sand and Gravel Association (NSSGA)
Dave Rettner, American Engineering Testing
Farhad Reza, Minnesota State University - Mankato
Roger Roberts, GSSI
Mohammad Reza Sabouri, Braun Intertec
Baris Salman, Syracuse University
Michael Scardina, Surface Tech
Nick Schaefer, Surface Systems and Instruments, Inc. (SSI)
Debbie Schwerman, Wisconsin Asphalt Pavement Association
Jo Sias, University of New Hampshire
Dan Staebell, Asphalt Pavement Alliance (APA)
Dave Stanczak, Asphalt Materials, Inc.
Brandon Strand, Asphalt Pavement Alliance (APA)
Nabil Suleiman, University of North Dakota
Hassan Tabatabaee, Cargill

Cheng Thao, Payne & Dolan
Chris Theriot, Resource Recycling Systems
Kim Tolzmann, Hardrives
Derek Tompkins, American Engineering Testing
Feng Wang, Texas State University
Hao Wang, Rutgers University
Randy West, National Center for Asphalt Technology (NCAT)
Jason Wielinski, ARRA
R. Chris William, Asphalt Materials & Paving Program (Iowa State)
Richard Willis, National Asphalt Pavement Association (NAPA)
Trey Wurst, Ingevity
Jett Yang, Uberbinder
Fan Yin, NCAT
Hao Yin, Horizon Engineering Consulting
Zhanping You, Michigan Tech Transportation Institute
Fujie Zhou, Texas A&M Transportation Institute

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2022 MnROAD Construction Overview

Main theme from NRRA: Sustainability and Resilience
What new materials will help meet future sustainability guidelines?

45 New Test Sections
- 4 – In-Place Recycling
- 4 – Preventive Maintenance
- 6 – PCC Innovative Patching / Diamond Grinding
- 16 – PCC Reduced Cement
- 1 – PCC WIM area
- 2 – PCC Recycled Fiber
- 2 – HMA Perpetual Pavement
  - 1 of 2 with Wicking Geotextile
- 10 – Reflective Cracking Challenge

Partners Donated Materials
- CAT – HMA Milling
- Geotextile Fabric
- VRAM – J-Band
- CIR Rejuvenator Donation

MnDOT Furnished Materials
- HMA Plant Mix Furnished (~1/2 mixes)
  - Additive Suppliers
- PCC Plant Mix Furnished (all mixes)
  - Additive Suppliers

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NRRA Flexible Team – Synthesis + 2017 Projects

- **2017 Projects**
  - **Developing Best Practices for Rehabilitation of Concrete with Hot Mix Asphalt (HMA) Overlays related to Density and Reflective Cracking**
    - **University of New Hampshire (Complete)**
  - **Cold Central Plant Recycling (CCPR)**
    - **AET (Complete)**
- **2017 Synthesis**
  - **Longitudinal Joint Construction Performance**
    - **SRF (Complete)**
  - **Tack Coats**
    - **SRF (Complete)**
- **2019 Synthesis/Projects**
  - **Mix Rejuvenator Synthesis (Phase 1)**
    - **WSB (Complete)**
  - **Cold Asphalt Recycling Technologies using Rejuvenating Asphalt Emulsion: Impact, Implementation, Specification**

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NRRA Mix Rejuvenator Study

- 7 products included in 2019 mill/inlay job
- Northern Minnesota (Emily, MN)
- RAP content increased to 40%

- Mfgs. asked to target xx-34 (original 58-28)
- Measuring long-term:
  - Field performance, asphalt binder + mix properties,
- Funded for additional 4 years!

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NRRA Flexible Team - Newly funded projects for 2019

- **Asphalt Real Time Smoothness (ARTS) for Asphalt Paving**
  - **Transtec (ICT co-sponsored - Complete)**
- **Impact of Polymer Modification on IDEAL-CT and I-FIT for Balanced Mix Design**
  - **NCAT (complete)**
- **Novel Methods for Adding Rejuvenators in Asphalt Mixtures with High Recycled Binder Ratios**
  - **University of New Hampshire (Complete)**
- **Understanding and Improving Pavement Milling Operations**
  - **University of New Hampshire**
  - **CAT Partnership**
  - **(ICT co-sponsored)**

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NRRA Flexible Team - Newly funded projects for 2021

- **Recycled Binder Availability**
  - **RFP in January 2024**
- **Reclamation and Recycling Techniques to Achieve Perpetual Pavements Characteristics**
  - **Co-sponsored with Geotech, ICT, and PM teams**
  - **Braun Intertec**
- **Validation of Loose Mix Aging Procedures for Cracking Resistance Evaluation in Balanced Mix Design**
  - **NCAT**
- **Perpetual Pavements in Wet-Freeze Climates**
  - **RFP in January 2024**
- **MnROAD Reflective Cracking Challenge**
  - **University of New Hampshire**

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2022 MnROAD Reflective Cracking Challenge

- **Experiment designed to better match APT research to MnDOT network applications**
  - BOB = bituminous over bituminous ~50% network

Statewide (All Districts)

Pavement	Percent	Miles
BIT	12%	1,682
BOB	50%	7,104
BOC	22%	3,136
CON	17%	2,377
CRCP	0%	2
All	**100%**	**14,301**

Pavement	PQI	RQI	SR
BIT	3.6	3.5	3.8
BOB	3.3	3.2	3.4
BOC	3.4	3.3	3.6
CON	3.6	3.4	3.9
CRCP	3.8	3.6	4.0
All	**3.4**	**3.3**	**3.6**

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NRRA Reflective Cracking Challenge MnROAD Test Sections

10 Test Sections with different HMA surfaces
- Tied to NCAT additive group 2021 construction
- Missouri funded 400K to tie Missouri Test Sections into each study
- ~450' of paving per surface mix (50' transitions)
- 200' of sawing to recreate/induce reflective cracking
- Milled before final 2" was placed

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NCAT Additive Group -Surface HMA Mix Details

- **10 Sections with differing surface HMA**
  - <u>Controls</u>
    1. PG 58H -34 (modified)
    2. PG 58S -28 (unmodified)
    3. PG ~49 -34 (unmodified)
  - <u>Additive Sections</u>
    4. Aramid Fiber 1 w/ PG 58H -34 (modified)
    5. Aramid Fiber 2 w/ PG 58H -34 (modified)
    6. Dry Plastic Additive w/ PG ~49 -34
    7. Dry Rubber Additive w/ PG ~49 -34
    8. Wet Plastic Additive ⎤ **w/ PG 52-34 from Mathy**
    9. Wet Rubber Additive ⎦
  - <u>Super Pave 5.0</u>
    10. PG 58V -34 (modified) (NRRA)

- **All mixes contain**
  - MnDOT Traffic Level 5 (10<30 mESALS)
  - Superpave Gyratory BMD
  - ¾" Max Agg (SP 12.5mm)
  - 20% RAP

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NRRA Flexible Team - Newly funded projects for 2023

- **Continued Monitoring of Original I-94 Westbound Asphalt Overlay Sections and Use of Cracking and Performance Data MRCC Project**
  - **University of New Hampshire**
- <u>**Mix Rejuvenator Test Sections (Phase 2)**</u>
  - **University of New Hampshire**
- **Field Validation of Using Warm Mix Asphalt at Reduced Production Temperatures for Balanced Mix Design**
  - **NCAT and Ingevity**
- **Materials-Based Methods to Improve Rumble Strip Durability**
  - **Asphalt Materials, Inc., Heritage Research Group, Behnke Materials Engineering**
  - **(co-sponsored with PM Team)**
- **Standardization of SIP Calculation for Hamburg Wheel Tracking Test**
  - **NCAT**

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NRRA Spray-Applied Rejuvenator Study

- **12 different products applied in 2021**
- **Applied at 3 locations**
  - MnROAD 58-28 (50')
  - MnROAD 58-34 (50')
  - St. Michael (500')
- **Measuring long-term:**
  - Friction, paint reflectivity, permeability, asphalt binder
- **Over 1,500 cores taken in first 2 years of study**

10/24/23   mndot.gov

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National Road Research Alliance (ICT Technical Team Projects)

Project	Org
Levels 3-4 Intelligent Compaction Measurement Values (ICMV) for Soils Subgrade/Aggregate Subbase Compaction	Transtec Group
Support Importing, Viewing and Analysis of Dielectric Constant Data in Veta (paid by Veta pooled fund)	Transtec Group
HD and VHD Seismic Approaches for Roadway Evaluation	Park Consulting
Asphalt Real Time Smoothness (ARTS) for Asphalt Paving	Transtec Group
Veta Web and Veta MDMS Standardized Platform	Transtec Group
InfoPAVE MnROAD Database Support and Development	i-Engineering
Effective Use of Traffic Speed Deflectometer for Network-based and Project-based Applications	UTEP
Establishing Applicability of NDT Methods for Project-Level Evaluation	UTEP
E-Ticketing	SRF

- **Veta Software** TPF-5(334) now NRRA
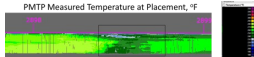- HMA Rolling Patterns
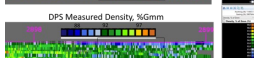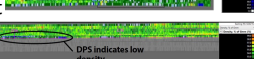- Paver Operations / IR Temperature Bar
- 3D GPR / Rolling Density Meter

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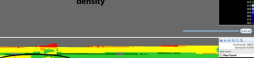## DPS National Pooled Fund Program

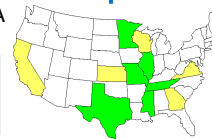**Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS) [TPF-5(443)]**
- **Objective:** Use the DPS method to improve asphalt pavement density
  - Increased coverage and comprehensiveness of assessment
  - Timely information to improve construction process
  - Reduce coring
- **Lead Agency:** MnDOT
  - Contact: Kyle Hoegh, kyle.hoegh@state.mn.us (MnDOT)
- **Committed agencies:** MN, FHWA, GA, ID, MD, ME, MO, MS, ND, NY, OH, PADOT, UT, WA, WI
- **Commitment level**: $25K/year

PMTP Measured Temperature at Placement, °F

DPS Measured Density, %Gmm

DPS indicates low density

IC indicates low number of breakdown roller passes

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Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing

TPF-5(504): Continuous Bituminous Pavement Stripping Assessment Through Non-Destructive testing (4 years)
- **Objective:** Develop testing and analysis procedures for automatic detection and rating of stripped section for project and network level pavement evaluations
- **Lead Agency:** MnDOT
  - Contact: Eyoab Zegeye, eyoab.zegeye@state.mn.us (MNDOT)
- **Committed agencies:** MN, IL, MO, TN, MS, TX, GA & FHWA
- **Pending**: CA, KS, WI, VA and IN
- **100% SP&R Approval:** Approved
- **Commitment level**: $25K/year

SCAN US

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"MnROAD Construction Prospects"

Fall of 2023
- Wisconsin Perpetual Pavement Installation (done)
- Local Reflective Cracking Experiment - 4 Cells on the LVR (31,77,78,79)
- Unbound Water Repellency – NRRA/NSF effort – 2 Cells (NW corner of the LVR)

2024
- HMA Stripping Calibration Sections – Pooled Fund – 12 Cells (LVR service road)
- 11 Mainline Test Sections (Open)
  - NRRA Cement Alternatives
  - NRRA Thick Lift HMA

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Questions / Comments

Working together you can be a part of something bigger than yourself

Ben Worel
ben.worel@state.mn.us

How to get involved?
- TPF-5(466) NRRA Membership
- TPF-5(TBD) NCAT 2024 Test Track
- TPF-5(522) PG3 Pavement Preservation
- TPF-5(443) Density Profile System
- TPF-5(504) Non-Destructive Testing
- Research Pays off Webinars (free)

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