Sustainable Transportation Initiatives

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Sustainable Cities Network

January 19, 2012

Presentation Outline

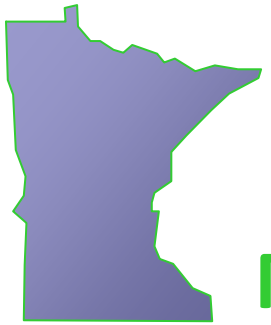
- Introduction to MnROAD
- Transportation & Road Research Alliance
- Sustainability Overview
- Sustainable Materials
- Sustainable Construction Practices

Disclaimer

- My background is in pavement materials
  - But I won't bore you with technical details
- Focus will be on practical implementation of research results

- Feel free to ask questions throughout the talk
  - Chat or phone

Introduction to MnROAD



MnROAD

Office of Materials and Road Research

A long-term accelerated pavement testing facility that gives researchers a unique, real-life laboratory to study and evaluate the performance of materials used in roadway construction.


Low Volume Road
Interstate 94
Mainline

MnROAD Original Construction

History of Test Sections

- Original Funding ($25M)
- Original Construction (‘92-’93)
- Open to Traffic (‘94)

Layout and Designs

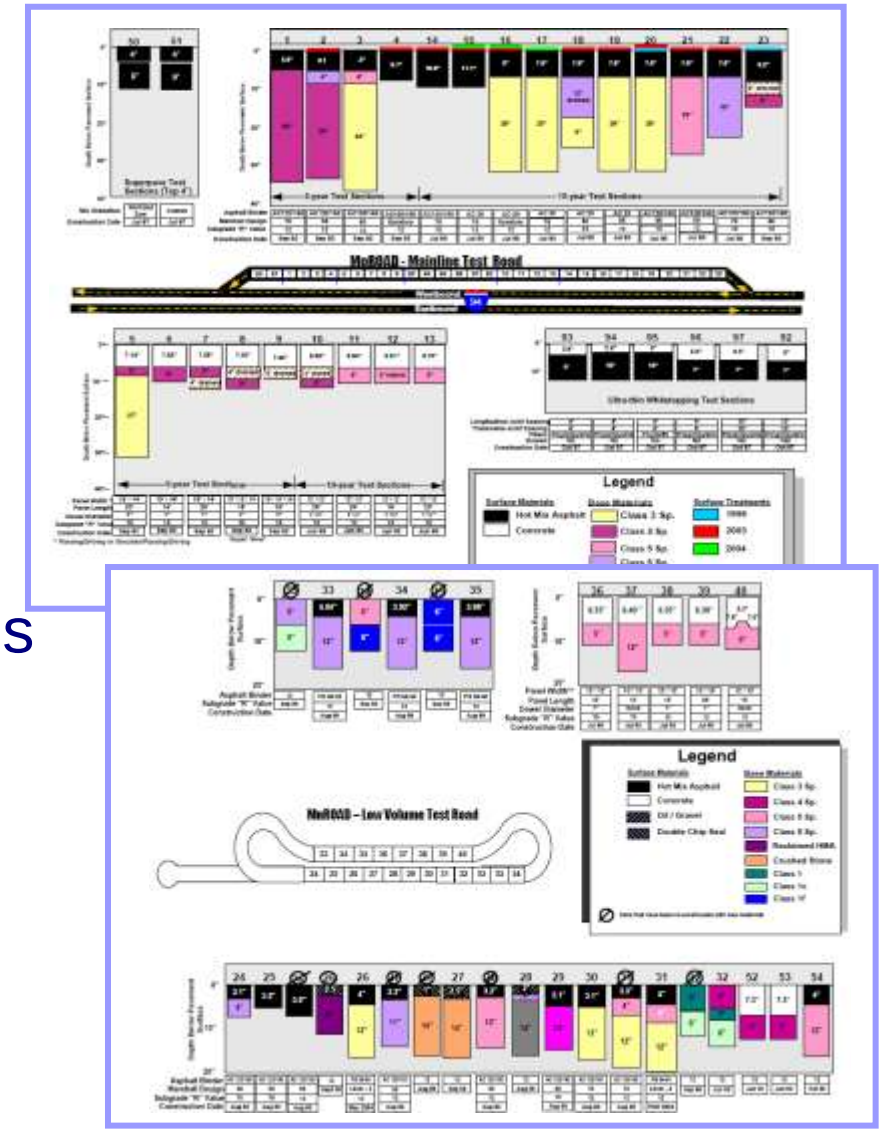
- Mainline / Low Volume Road
- Asphalt, Concrete, Aggregate Cells
- 3,5,10 Year Designs

Phase I

- 1994-2006

Phase II

- 2007-present



MnROAD Operations

- Traffic Loading
  - LVR 80K Truck, ML Traffic Switches
- Performance Monitoring
  - Coordination, Collect & Share Data
- Instrumentation & Data Management
  - 9000+ Sensors
  - Oracle Database
- Research Support
- Facility / Buildings

MnROAD Traffic Loadings

Low Volume Road Traffic

MnROAD 5-axle Semi
Inside Lane = 80k truck 5 days/week
Outside Lane = 102k truck (pre-2007); no traffic since then

Mainline Traffic

I-94 WB Public Traffic
28,500 AADT
12.7% Trucks

Pavement Performance Monitoring

- Non destructive testing
- Dynamic load testing
- Distress surveys
- PCC joint faulting
- Surface characteristics
- HMA rutting
- Coring
- Forensics

Instrumentation

Static (Environmental) and Dynamic (Traffic Load)

Soil Pressure

HMA and PCC Strains

Deflection

Temperature

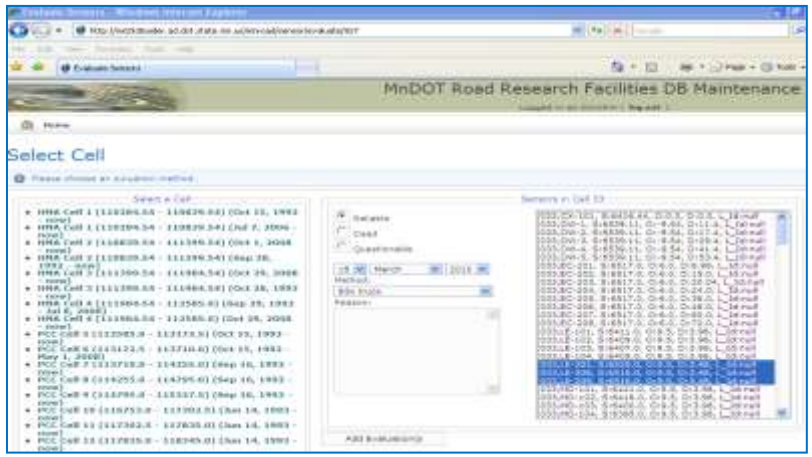
Moisture

Frost

Water Quality

MnROAD Database

- 17 years of data (some data every 15 minutes)
- Over 1 Billion rows
- SQL-Relational Database
- Contents
  - Test section parameters
  - Sensor data
  - Monitoring data
  - Lab testing results
- Current activities
  - Table reorganization
  - Data validation procedures
- MnROAD Data Release



MnROAD Phase I Benefits

- Improved policies and specifications save Minnesota $33M annually
- Seasonal Load Limits
- Improved Design Methods
- Improved Construction Techniques
- 17 Years of Data to Share

Core Research Areas

- Innovative Construction
- Green Roads
- Preservation and Rapid Renewal
- Surface Characteristics
- Non-Pavement Research

Transportation Engineering and Road Research Alliance

TERRA

Formation of TERRA (2004)

- Initial MnROAD research being completed
- Task Force of government, industry and academia to plan future phase
- Recommended a broad governance structure:
  - Reflect capacity/interests of partners
  - Attract key public, industry, academic partners to contribute resources, guide future initiatives
  - Serve broader research community

TERRA Mission

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 Vision

A dynamic partnership of government, industry, and academia that continuously advances innovations in road engineering and construction.

Board Members

Industry

- Aggregate & Ready Mix Association of MN*
- American Concrete Pavement Association
- Associated General Contractors of MN*
- Concrete Paving Association of MN
- MN Asphalt Pavement Association
- American Traffic Safety Services Association
- Caterpillar Global Paving
- Mathy Technology and Engineering Services
- RMC Research and Education Foundation
- Road Science**

National

- Norwegian Public Roads Administration
- United States Federal Highway Association

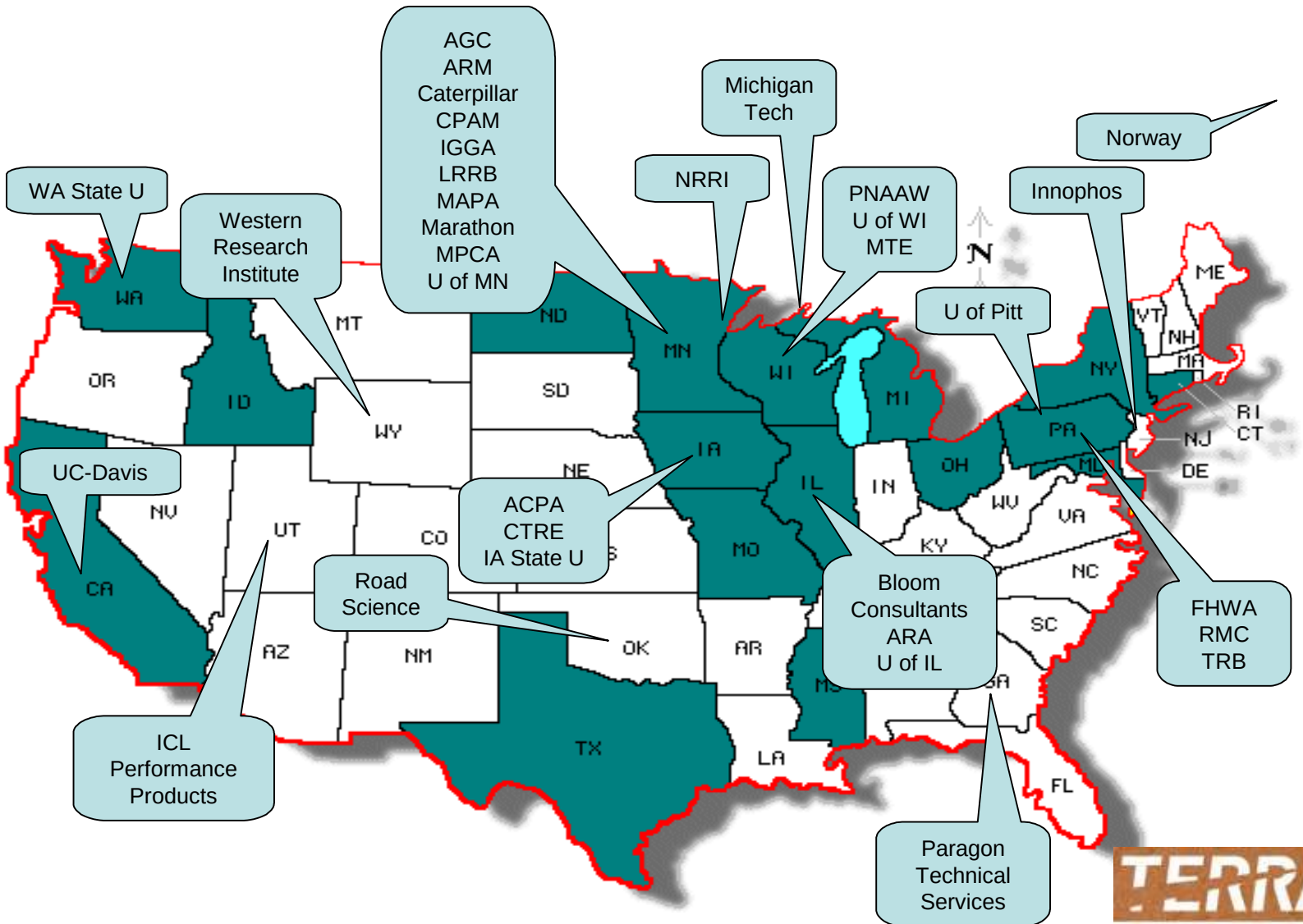
State and Local

- Minnesota DOT*
- Minnesota Local Road Research Board
- Iowa DOT
- Michigan DOT*
- New York State DOT
- North Dakota DOT
- Wisconsin DOT**

University

- Iowa State University
- Michigan Tech University
- University of Minnesota

TERRA – MnROAD Partners



TERRA Transportation Engineering and Road Research Alliance
Partnering for Roadway Innovation

Benefits of the TERRA Alliance

- Improved collaboration between public, private, industry, and academic stakeholders
- Capacity to anticipate future needs and trends
- Research partnership expansion
- Leverage funds to meet common goals
- Quicker adoption of innovations

Sustainability Overview

Guiding Principles

- Environmental
  - Be good stewards of natural resources
- Social
  - Be good neighbors and partners in the community
- Economic
  - Be financially responsible with tax dollars

Sustainable Materials

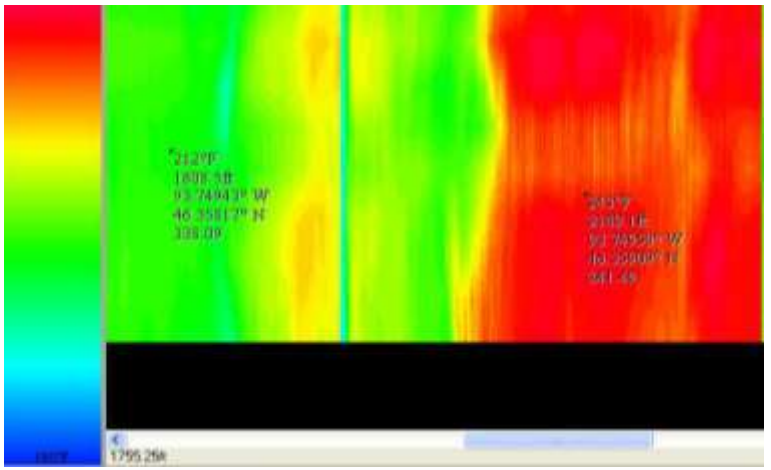
Motivation

- Sustainable Materials
  - Binders
  - Aggregates
  - Mixtures
- Lead to longer lasting pavements
  - Don’t sacrifice quality for the sake of sustainability

Warm Mix Asphalt (WMA)

- Technology that allows the reduction of mixing and compaction temperatures by 20 to 100 F
  - 50 F typical
- Acts as a lubricator
  - Reduces surface tension of asphalt binder
  - Allows binder to flow and coat aggregates

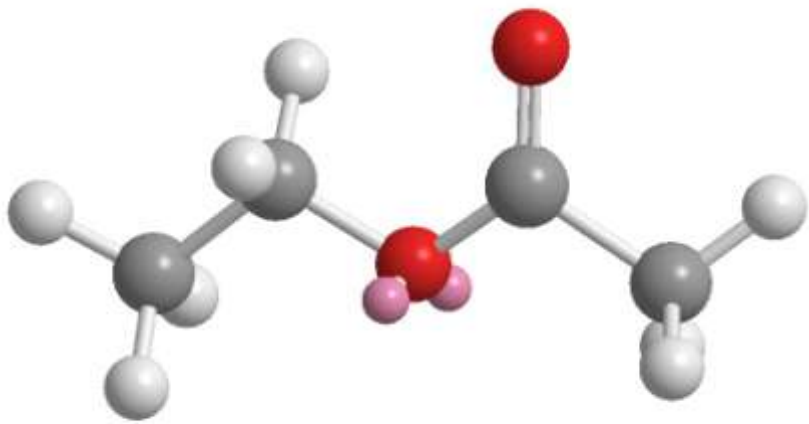
Benefits of WMA



- Environmental
  - Lower greenhouse gas emissions
  - Lower fuel consumption
- Operational
  - Better compaction
  - More comfortable working conditions
  - More uniformity
- Performance
  - Can use RAP and/or shingles with WMA
  - Eliminates bumps in overlays
  - Reduced binder aging – reduced cracking

WMA Technologies

- Foaming Technologies
  - Water
  - Additive
- Organic Additives
  - Wax
- Chemical Additives
  - Surfactants
  - Anti-strip agents



~ 30 technologies available in US

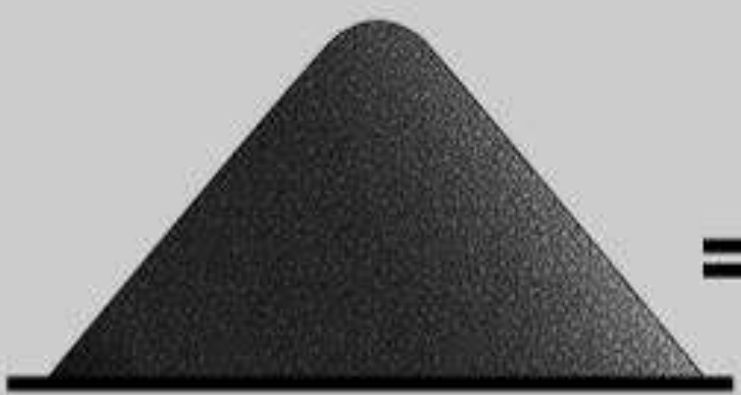

WMA vs. HMA

Recycled Asphalt Pavement (RAP)

- Recycle old asphalt pavement into new mix
  - Mill or excavate
  - Crush and/or screen to size
  - Best practices for material handling
- 0-50% RAP used throughout country
  - 15% national average

RAP Benefits

- Reduce carbon footprint of product
- Conservation of natural resources
- Conservation of landfill space
- Stabilize material costs, i.e. raw material costs continually fluctuate
- Mixture durability (cracking potential, moisture damage) can be a concern



30,000 Tons of RAP

=

70 - 6,000 Gallon Transport Trailers
and 28,200 Tons of Clean Aggregate

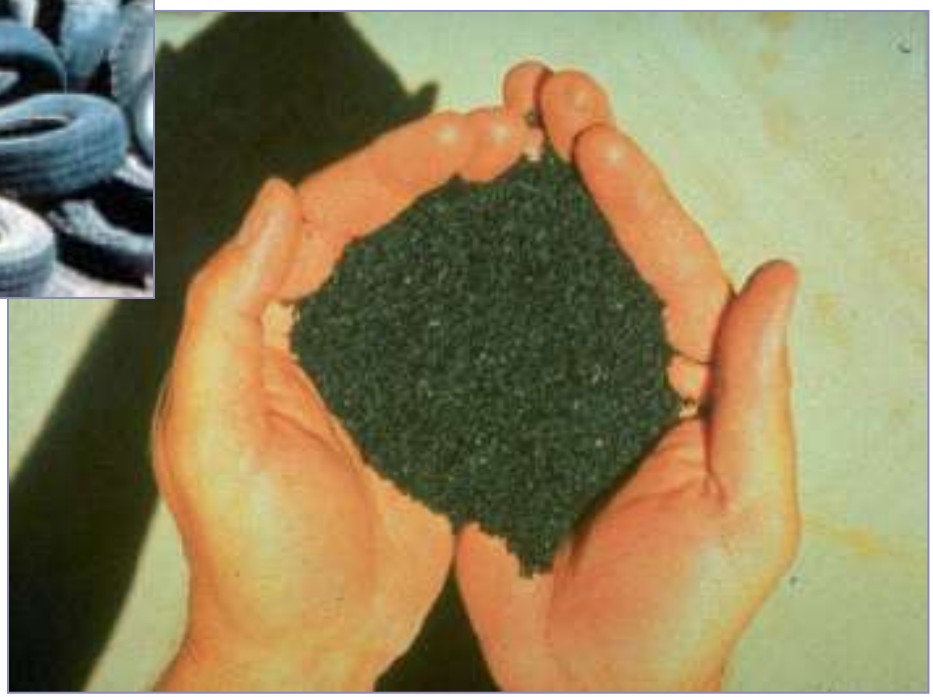
Recycled Asphalt Shingles (RAS)

- Contain sand, (very stiff) asphalt, fiber
- MnDOT allows both manufactured waste (MW) shingles and tear-off (TO) shingles
  - Up to 5% shingles
  - No more than 30% of total binder from RAS/RAP
    - Iowa requires mix fracture test if above 30%
- Mixture durability is again a concern

Processing is Key

Ground Tire Rubber

- 280 million scrap tires generated annually
- Different ways to process into asphalt mix
- Elastic properties improve performance
- Significant noise reduction
- Arizona is a national leader in this technology

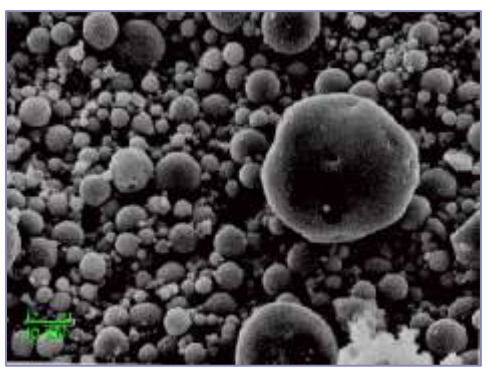


Recycled Concrete Pavement

Similar issues to RAP

Fly Ash

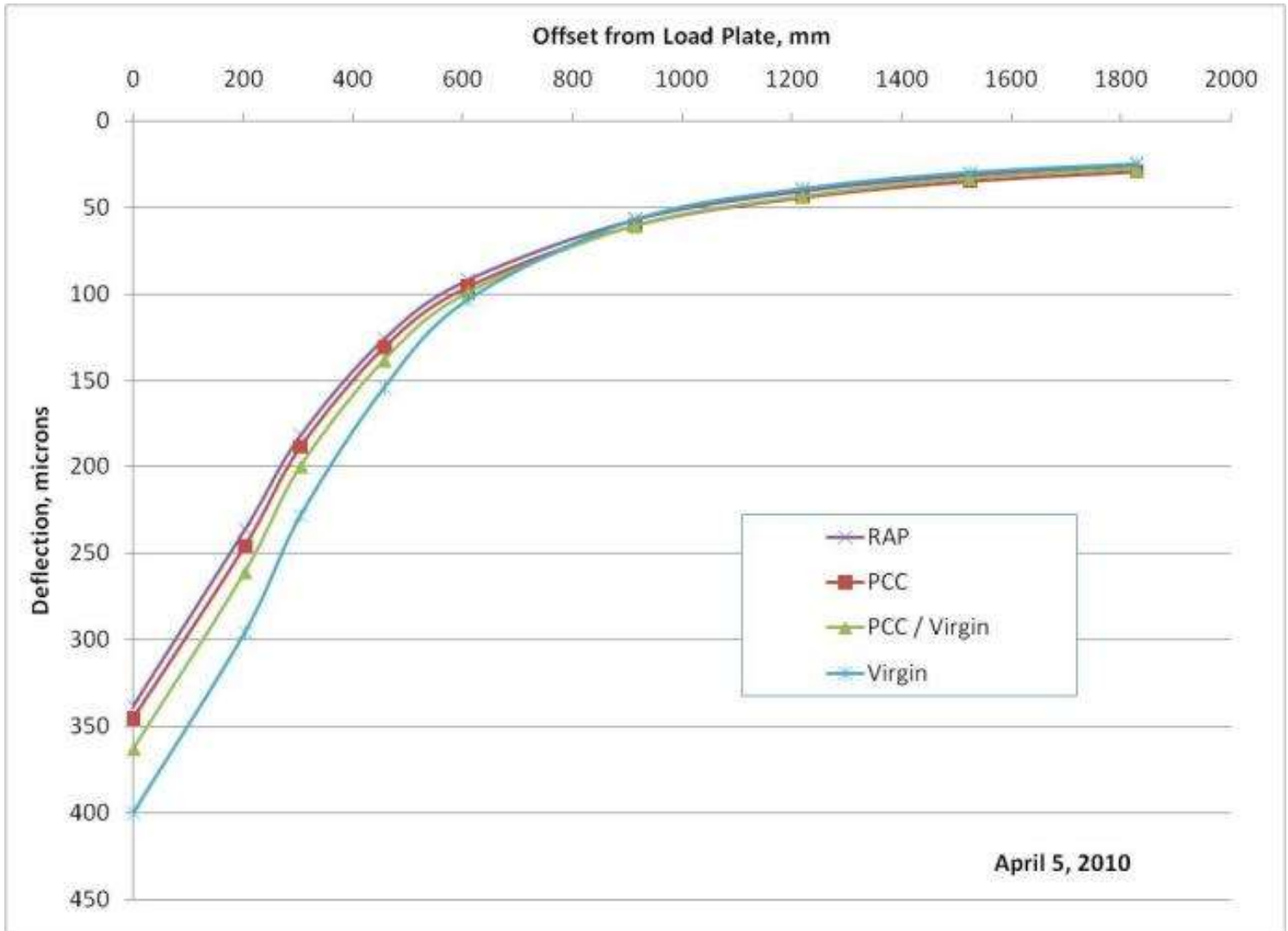
- Cementitious properties bind materials together
- Replace portion of cement in concrete pavement
  - Also slag, silica fume, etc.
- Stabilize unbound base and subgrade layers



Recycled Unbound Base Materials

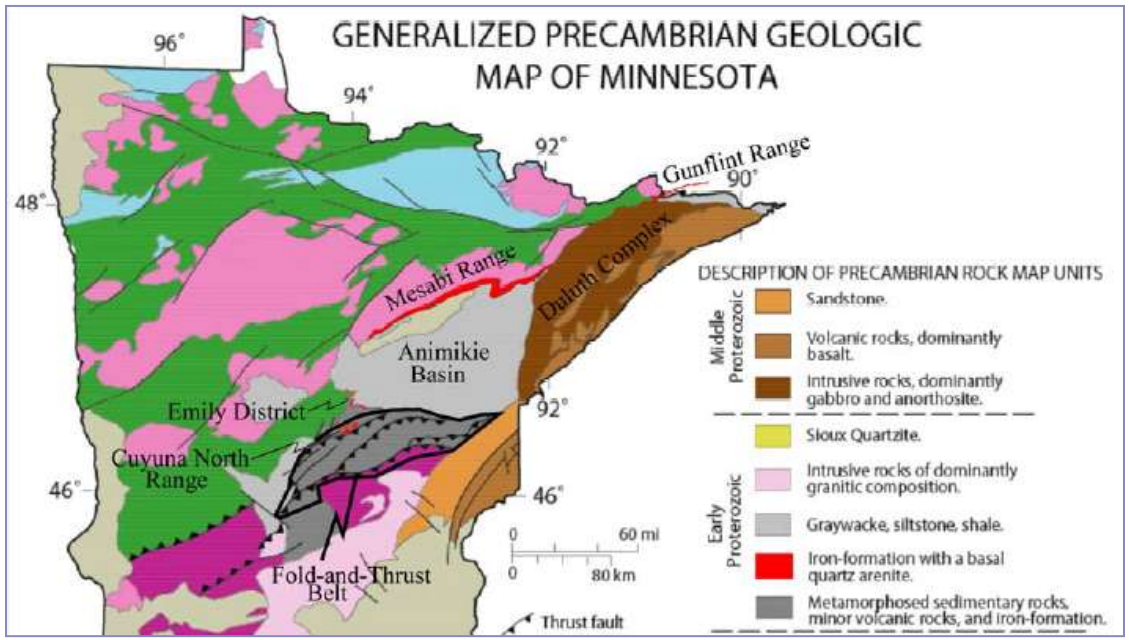
- Can be used as unbound base materials
  - 100% recycled concrete
  - 50% recycled concrete + 50% class 5 granular
  - 100% recycled asphalt (RAP)
  - Class 5 aggregate (control section)
  - Also allow glass, brick, other construction demolition
- How do these materials perform in different seasons and with time?

Variable Deflection under Load



Taconite Aggregate

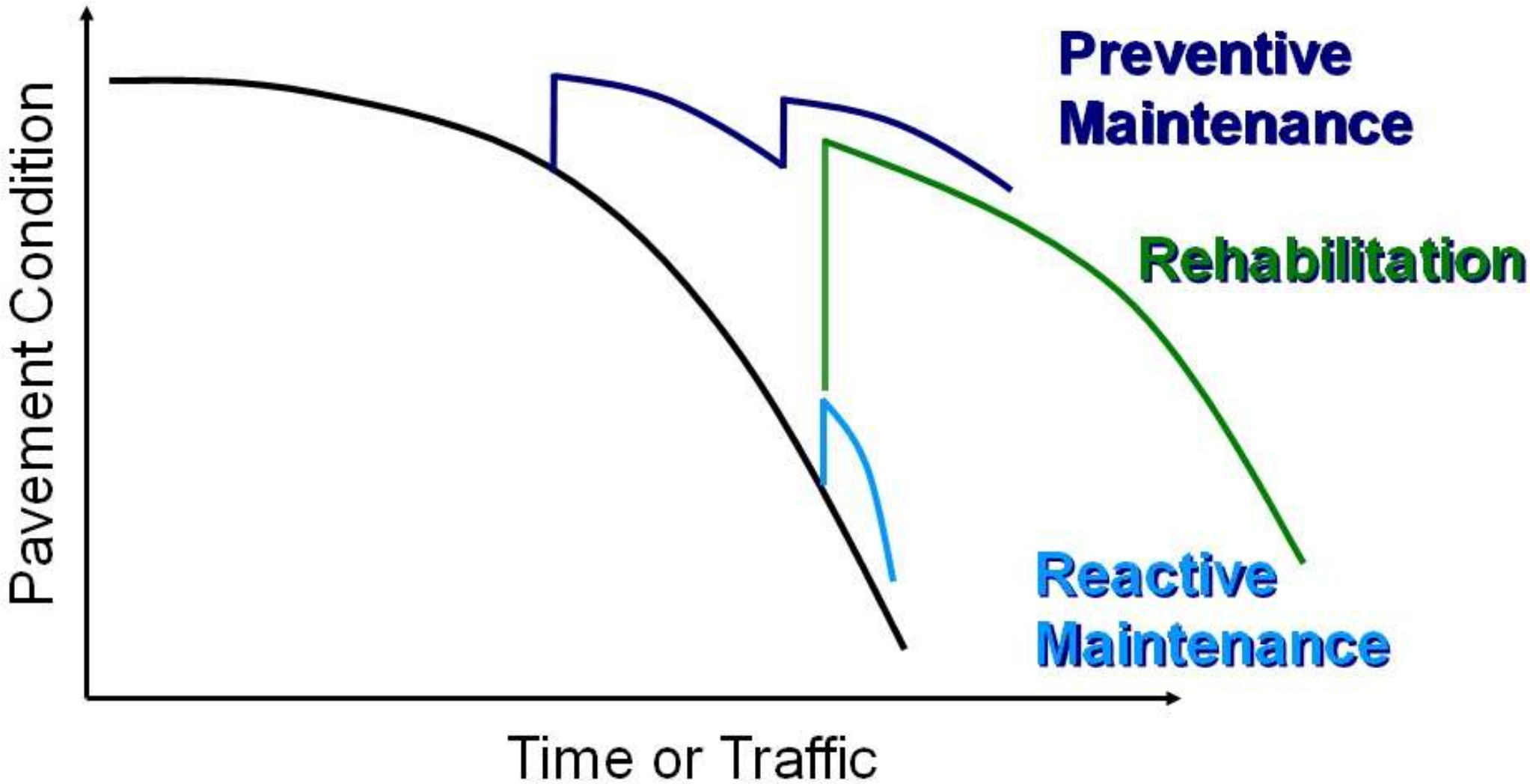
- Waste product from mining on the Iron Range in Minnesota
  - Abundant
  - High quality (hard, durable, angular)
  - Low cost (although transportation costs must be considered)



Taconite Applications

- Typical asphalt pavement
- Thin lift asphalt pavements
- Typical concrete pavements
- Railroad ballast / aggregate base
- Maintenance / pothole patches

Sustainable Construction Practices


Pavement Condition
Time or Traffic
Preventive Maintenance
Rehabilitation
Reactive Maintenance

Surface Treatments

- Fog Seal
- Chip Seal
- Slurry Seal
- Microsurfacing

MnROAD Maintenance Treatments

- Successful in reducing rutting
- Cracking returns after 1 winter
- Single and double slurry treatments with transverse crack repair (i.e., multiple maintenance applications) are performing best
- Crack Seal ride quality

Hot In-Place Recycling

- Heating, scarifying, and replacing the top 1-2 inches of asphalt surface
- Correct surface distresses
- Improve pavement surface profile

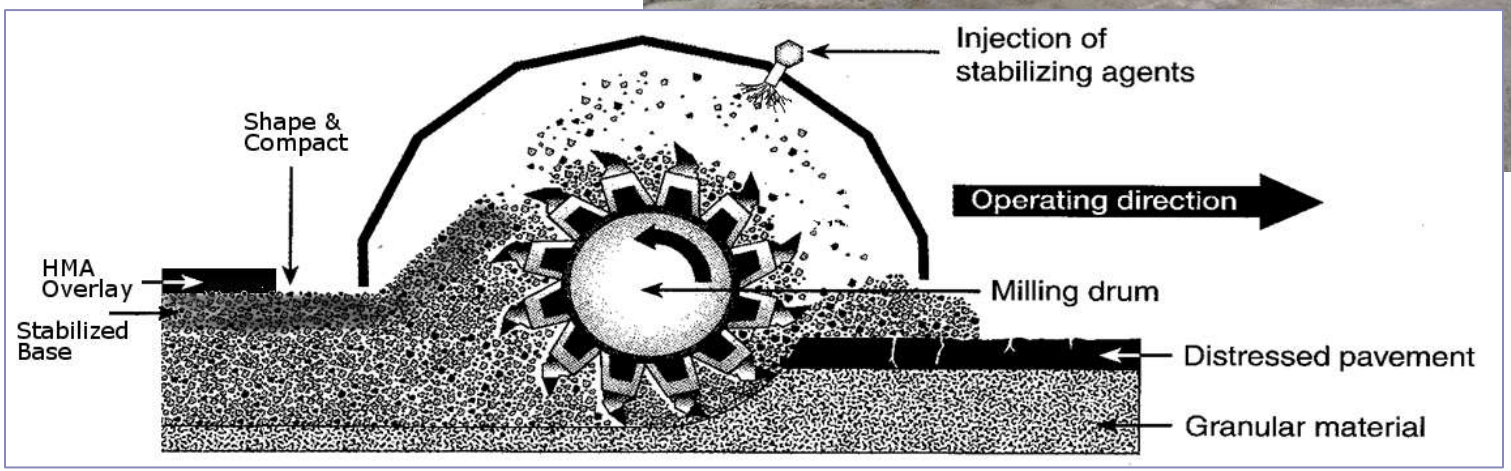
Cold In-Place Recycling

- Milling, rejuvenating, and replacing of top 2-4 inches of asphalt surface
- Performed at ambient temperatures
- Correct mid-depth to surface distresses
- Improve pavement surface profile
- Arizona is a national leader in this technology

Full Depth Reclamation

- Combine entire asphalt pavement and a portion of the underlying base material
- Uniformly crushed, pulverized, and blended
- Possible further stabilization with cement, fly ash, lime, foamed asphalt, or asphalt emulsions
- Rehabilitates failed asphalt pavement


TIANGONG
ZBL2500

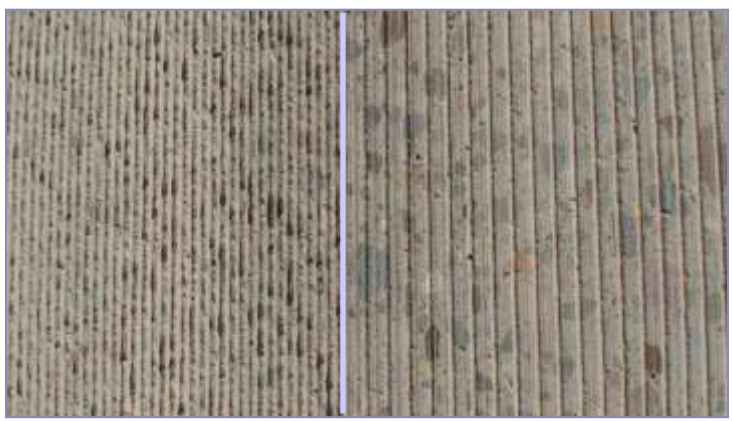

Injection of
stabilizing agents
Shape &
Compact
Operating direction
HMA
Overlay
Stabilized
Base
Milling drum
Distressed pavement
Granular material

Lessons Learned from FDR

- FDR projects have demonstrated rapid, cost effective construction experience
- MnROAD FDR sections constructed in 2007 and 2008 show a measurable increase in strength vs. conventional aggregate bases

Innovative Diamond Grinding

- Restore smoothness to concrete pavement
  - Faulting, Patching
- Ongoing cooperative efforts between government, industry, and academia
- Deployed on several MnDOT highway projects

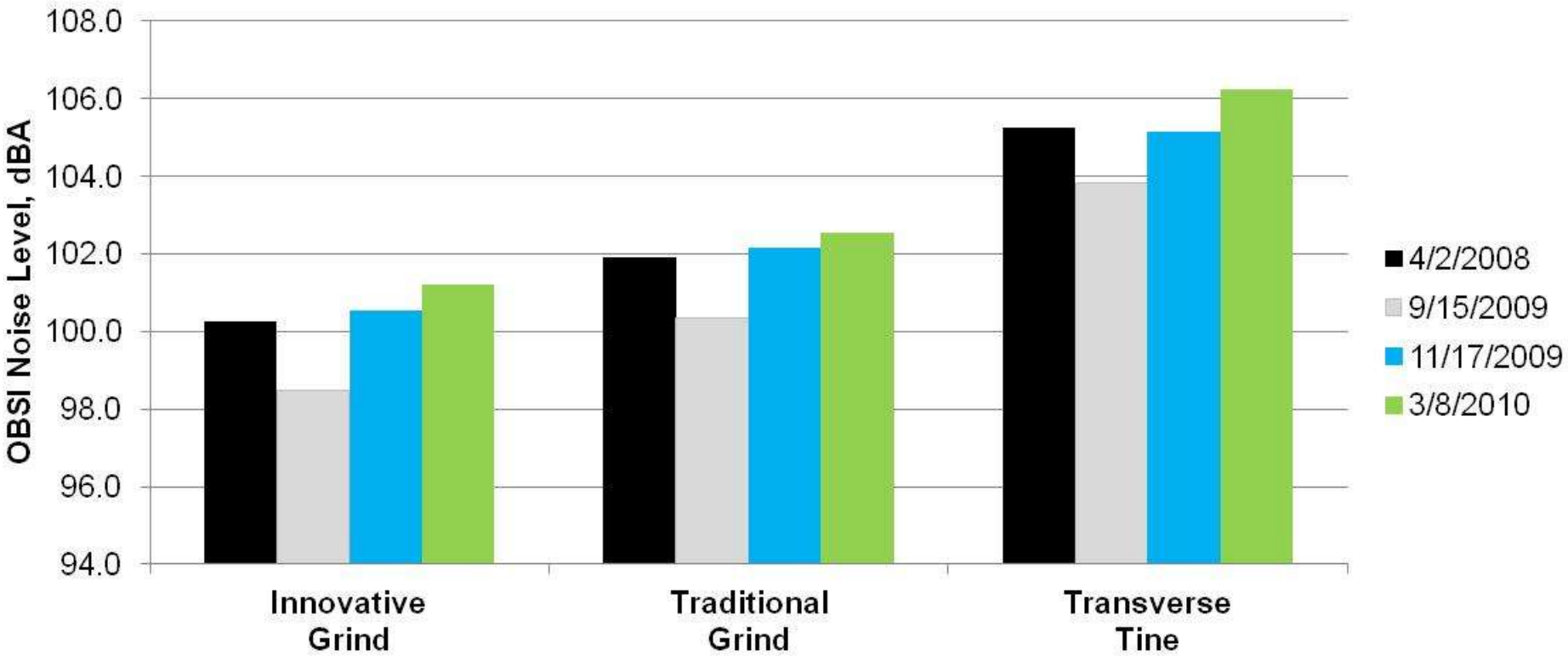


Reduces Tire-Pavement Noise

- Innovative Grind

- On-Board Sound Intensity Test (OBSI)

Quietest Concrete Pavement in North America!

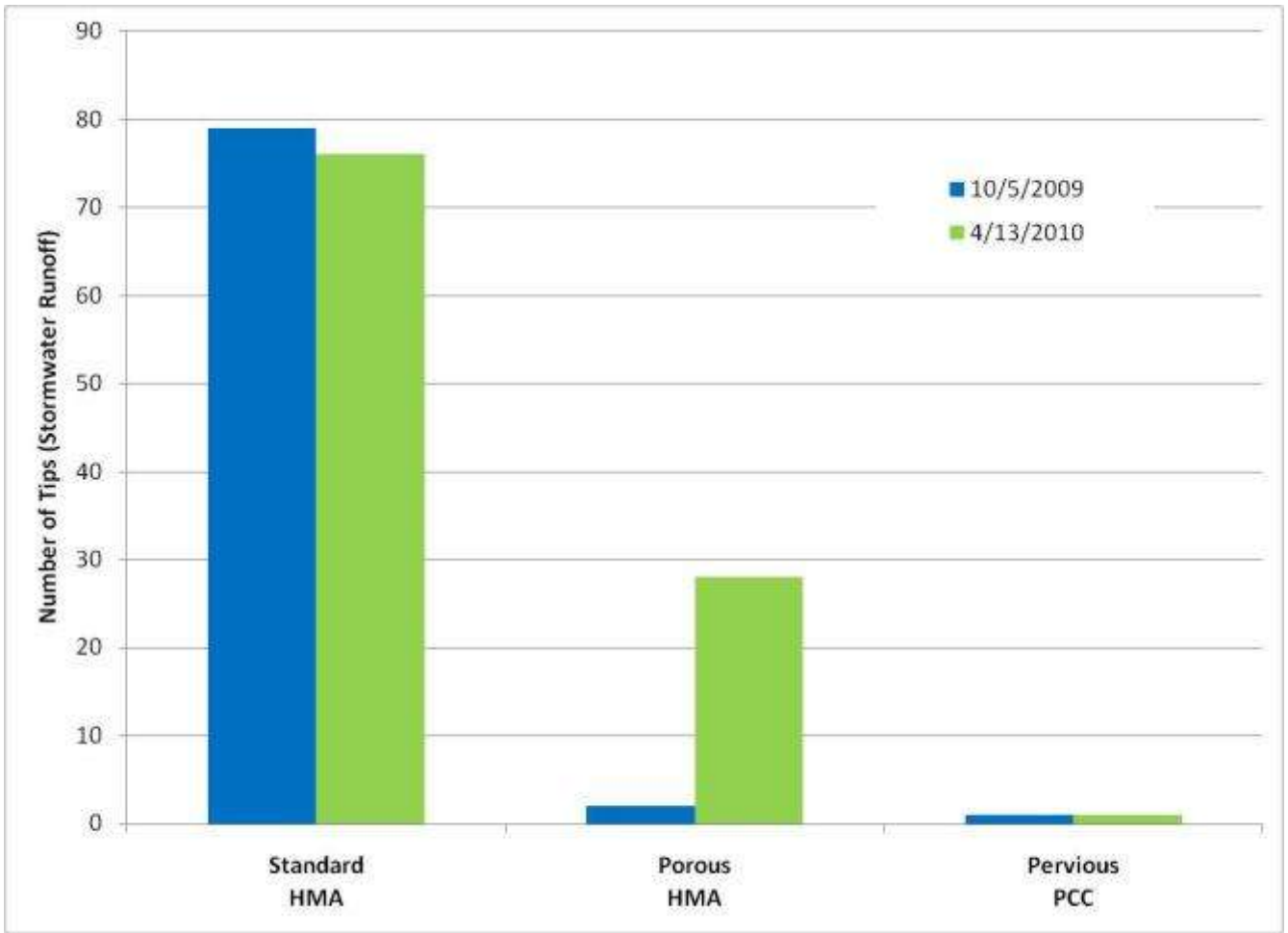


Permeable Pavements

- Porous Asphalt
- Pervious Concrete
- Pervious PCC Overlay
  - Pavement Durability
  - Maintenance Needs
  - Water Quality and Quantity
  - Traffic Safety

- Potential Applications
  - Park & Ride Lots
  - Local Access Roads
  - Roundabout Aprons
  - Emergency Pulloff Areas
  - In lieu of retention ponds

Benefits



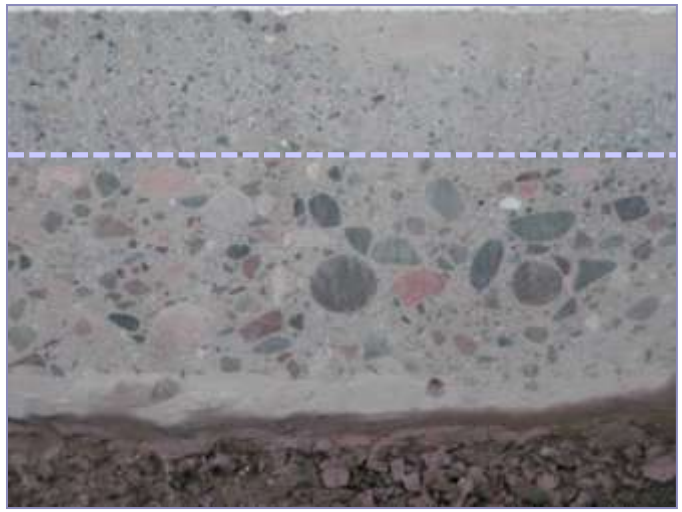
- Reduce storm water runoff
- Reduce noise
- Reduce splash & spray

Composite Pavements

- High quality materials in pavement surface
- Lower quality materials in lower layer
- Reduce costs
- Lengthen pavement life

Composite Pavements

- Two-lift (wet-on-wet) concrete paving
- Sustainable concepts
  - 50% recycled (MnROAD) concrete as PCC aggregate
  - Up to 60% cement substitution
- Exposed aggregate surface
- Contractor's scenario showed it was cost-competitive



Thin Concrete Overlays

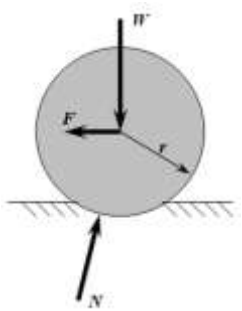
- Thick overlays have proven successful
- Can thinner overlays be a more economical solution?
- Supported by concrete industry
- Working on rational design tools

Ramsey County Library

- Rainwater gardens, native plantings
- Preferred parking spaces
  - Carpools
  - Fuel efficient vehicles
- LEED Gold Certified

Rolling Resistance

- Tested all ML & LVR cells: HMA & PCC
  - Jerzy Ejsmont (U of Gdansk), Ulf Sandberg (VTI)
- Funding from FHWA, MnDOT via pooled fund projects
- Research Goals:
  - Understand how pavement surfaces affect rolling resistance
  - Correlate rolling resistance to other surface characteristics
  - Reduce energy consumption, GHG emissions



Conclusions

- Sustainable materials & construction techniques are already being used
- Lower Construction Costs
- Shorter Construction Time
- Improved Pavement Performance

Thank You!

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