Presentation Outline

- Introduction to MnROAD
- Phase-I Benefits
- Phase-II Benefits
- Phase-III Future
Presentation Outline

- Introduction to MnROAD
- Phase-I Benefits
- Phase-II Benefits
- Phase-III Future

(the so-what without the dirty details)
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.
MnROAD Original Construction

**History**
- Original Funding ($25 million)
- Open to Traffic (1994)

**Layout and Designs**
- Mainline / Low Volume
- Asphalt / Concrete / Aggregate
- 3,5,10 Year Designs

**Phase I (1994-2006)**
**Phase II (2007-present)**
**Phase III (?)**
MnROAD Operations

- Facility/Buildings
- Construction coordination
- Traffic loadings
  - LVR 80K Truck and ML Traffic Switches
- Research project support
- Performance monitoring
- Sensors (9,000+ installed)
  - Static (Environmental)
  - Dynamic (Traffic Loading)
MnROAD Database

- **Oracle Database**
  - Over 1 Billion rows

- **Data Release 1.0 (January 2012)**
  - Test cell parameters
  - Monitoring/Performance
  - Lab testing results

- **Current Activities**
  - Sensor data
  - Table organization & data validation procedures
  - Web access
MnROAD Research Support

- Intelligent Transportation Systems (ITS)
- Pavement Marking (Striping)
- 60 inch Plastic Culverts
- Roadside Vegetation Studies
- SRF Loop Detector Installation
- Homeland Security Drills
- AGCO Corp. Machine Testing
- State Patrol Accident Reconstruction
- Profile and Noise Rodeo Support
- Site and District Snowplowing
- WIM Calibration, Truck Instrumentation
MnROAD Phase I Accomplishments

Saves 33 million Annually

- Seasonal Load Limits
  - Spring Restrictions / Winter Overloads
- Improved Design Methods
  - Mechanistic Empirical Designs
- Improved Construction Methods
  - Profiler Certification
  - Dynamic Cone Penetrometer
  - Intelligent Compaction
- Initial Findings
  - Environment Drives Pavement Performance
  - Current Designs are too Conservative
- Young Engineer Training & Education
Transportation Engineering and Road Research Alliance

- TERRA formed in 2004
- Helped develop Phase-II
- Currently 21 government, industry and academia members

MnROAD Benefits

- Attracts key public, industry, academic partners contributions
- Participation in working to develop future initiatives
Core Research Areas

- Innovative Construction
- Green Roads
- Preservation and Rapid Renewal
- Surface Characteristics
- Non-Pavement Research
MnROAD Phase II Major Research

- TPF-5(129) Recycled Unbound Materials
- TPF-5(134) PCC Characteristics (Rehabilitation)
- TPF-5(149) Composite Pavements
- TPF-5(148) Implements of Husbandry
- TPF-5(153) Preventive Maintenance
- TPF-5(132) Low Temperature Cracking
- TPF-5(165) Whitetopping Design
Recycled Unbound Materials

- **TPF-5(132) Pooled Fund**
  - Base Material Study
  - 4 Cells – (100% PCC, 50% PCC, 100% RAP, Class-5)

- **Observations**
  - All three sections performing well as control
  - Extensive lab testing

- **Benefits**
  - Better understanding of the seasonal material behavior
  - Inputs for future pavement designs
  - Modified MnDOT Granular Base Spec
  - Use of a greater percent of PCC in the base 75%
PCC Surface Characteristics (Rehab)

- **TPF-5(134) Pooled Fund**
  - Diamond Grinding Study - LVR to Mainline
  - Traditional, Innovative, Ultimate, Whisper, ....)

- **Observations**
  - Noise/Durable/Safety Improvements have been documented
  - Materials and Construction are starting to utilize
  - Working with the environmental groups
  - Cost are becoming more competitive with greater use

- **Benefits**
  - MnROAD, 94 Clearwater, 52 S. Airport, 35 Duluth
  - Noise/Durable/Safety
  - Good for areas where no room for noise walls
  - Other states are requesting our MnDOT spec
Composite Pavements

- **TPF-5(149) Pooled Fund & SHRPII**
  - Two lift designed systems
  - 4 Cells – (HMA/PCC, PCC/HMA)

- **Observations**
  - Good Performance – National Push
  - Demonstrated low quality aggregate, recycled concrete, flyash substitution options for underlying concrete mixes
  - Documented the reduced thermal gradient for HMA/Concrete and the future design possibilities

- **Benefits**
  - Economical option for locations with low quality/few aggregates
    - McCrossen Cost Estimate (2 PCC Pavers – Trucking Costs) are roughly equal
  - New designs options for long life, durable, rapid renewal
Implements of Husbandry

- TPF-5(148) Pooled Fund
  - Effects of farm equipment for roadways
  - 3 Cells – (HMA 7 and 9 ton and thin PCC)

- Observations
  - More damage in the afternoon
  - More damage with roads without shoulders
  - Larger equipment tends to show greater damage than a 5-axle semi
  - Equipment manufactures are moving towards smaller tanks

- Benefits
  - Wisconsin is implementing local meetings to stress communication of the issues, use of one-way roads, morning travel, road improvements
  - Potential for high savings of the local roadway system
Preventative Maintenance

- **TPF-5(153) Pooled Fund**
  - Understand asphalt aging
  - HMA Cells and other state roadways

- **Observations**
  - Study just got underway
  - Asphalt Institute
  - Laboratory study using cores
  - Roadways observed to age from top down and bottom up

- **Benefits**
  - Key to understanding when is the most effective time for maintenance
Low Temperature Cracking

- **TPF-5(132) Pooled Fund**
  - National mix test and specification
  - HMA cells and other state roadways

- **Observations**
  - Fracture Energy we are able to measure
  - Changes noticed for
    - Aggregate Type
    - Aggregate Gradation Size
    - Binder Grade
    - Binder Modification
    - Air Voids
    - Use of Recycle

- **Benefits**
  - Fracture energy key to thermal cracking but also all cracking
  - Give engineers more insight in the materials they select
  - Help eliminate the #1 reason we rehab roads in Minnesota
Whitetopping Design

- **TPF-5(165) Pooled Fund**
  - National design

- **Observations**
  - Learned the important factors – accelerated testing
    - Thickness
    - Panel size
    - HMA condition and seasonal behavior
    - Importance of bond
    - Importance of sealing

- **Benefits**
  - Positive Design for HMA Full depth repairs
  - Possible option if alternate bids become standard
Recycled Materials in Asphalt

- **MnROAD**
  - LVR and Mainline
  - Shingles and Fractionated RAP

- **Observations**
  - Demonstration
  - 5% Shingle shoulder mix cracked (both types)
  - Fractionated vs Non-Fractionated RAP – 30%
  - PG 58-28 (small amount of cracking) PG 58-34 (less)

- **Benefits**
  - Effect on base asphalt binder selection for RAP
  - Shingles can be a viable option
Permeable/Porous Pavements

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

Observations for both HMA/PCC
- Good pavement durability
- Voids remain open (traffic and maintenance)
- Maintained (2-3 times/year)
- Run-off and Water Quantity benefits
- Traffic Safety (Noise and Spray)
Permeable HMA Pavement

- **MPR-6(024) Single State**
  - 2 Cells (Sand – Clay Subgrade)

- **Observations**
  - 2008 MnROAD First (MnDOT, Contractor)
  - Held up to freeze/thaw
  - Good Performance (rutting, raveling, no cracks)

- **Benefits**
  - MnDOT Spec
  - Demonstrated construction
  - Demonstrated performance
Pervious PCC Pavement

- **MPR-6(027) Single State**
  - 2 cells (Sand – Clay Subgrade)
  - 1 cell (overlay)

- **Observations**
  - Progression of technology
  - Construction process
  - Held up to freeze/thaw
  - Good Performance (raveling, cracks)

- **Benefits**
  - MnDOT Spec
  - Demonstrated construction
  - Demonstrated performance
  - Construction – Industry certification classes
Thin Concrete

- **Pavements**
  - LVR and Mainline Cells

- **Observations**
  - LVR – 5” working better than expected
  - Mainline 5 and 5.5” failure in 2.5 years
  - Mainline 6 and 6.5” working for now
  - Note 7.5” mainline has worked for 17 years

- **Panel Size**
  - Flat dowel bars demonstrated

- **Benefits**
  - Can thinner overlays be a more economical solution?
  - Supported by concrete industry
  - Working on rational design tools
## MnROAD Phase II Major Research

<table>
<thead>
<tr>
<th>Date</th>
<th>Initiative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-07</td>
<td></td>
</tr>
<tr>
<td>Jan-08</td>
<td></td>
</tr>
<tr>
<td>Jan-09</td>
<td></td>
</tr>
<tr>
<td>Jan-10</td>
<td></td>
</tr>
<tr>
<td>Jan-11</td>
<td></td>
</tr>
<tr>
<td>Jan-12</td>
<td></td>
</tr>
<tr>
<td>Jan-13</td>
<td></td>
</tr>
<tr>
<td>Jan-14</td>
<td></td>
</tr>
<tr>
<td>Jan-15</td>
<td></td>
</tr>
<tr>
<td>Feb 2012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CTRE Partnership - PCC Pervious Overlay MPR-6(015)</td>
</tr>
<tr>
<td></td>
<td>RoadScience Partnership - FDR Repairs using Engineer Emulsion</td>
</tr>
<tr>
<td></td>
<td>NRRI Partnership - Taconite Aggregates MPR-6(023)</td>
</tr>
<tr>
<td></td>
<td>Innophos and FHWA Partnership - Acid Modification of HMA</td>
</tr>
<tr>
<td></td>
<td>Bloom - FDR - Fly Ash Stabilization</td>
</tr>
<tr>
<td></td>
<td>ARA Partnership - SHRP2 Composite Pavements</td>
</tr>
</tbody>
</table>

### Other Initiatives Include
- Warm mix asphalt (WMA)
- Effect of drainage on joint performance
- Open graded aggregate base (OGAB)
- Roller compacted concrete
Full Depth Reclamation

- **Bloom and FHWA Partnership**
  - 3 Cells (Low Volume Road)

- **Observations**
  - Use of fly ash and non-treated FDR provides
    - Increase in base strength
    - Demonstrated rapid, cost effective construction experience

- **Benefits**
  - Eliminates reflective cracking
  - Construction Insurance
Full Depth Reclamation

- **Road Science Partnership**
  - 3 Cells (mainline)
  - 1 Cell (LVR)

- **Observations**
  - 2.75” Interstate surface on engineered FDR
  - Engineered emulsion provides a balance stiffness and flexibility.

- **Benefits**
  - Design method for HMA Full depth repairs
  - Design method for distressed pavements
  - Sustainable construction practice
Taconite Aggregates

- **MnROAD**
  - LVR and Mainline
  - Base, PCC, HMA

- **Observations**
  - Both HMA and PCC working well
  - Large stone base (along with pervious) has about half the frost depth
  - Taconite 4.75mm SMA is very rut resistant
  - Working on a high quality patch material and system

- **Benefits**
  - Good high quality aggregate used in any layer of the roadway
    - Limited by transportation cost (trucking)
    - Consistent production for aggregate size
Warm Mix Asphalt

- **Base asphalt used at MnROAD**
  - 6 Cells (mainline) - Evotherm

- **Observations**
  - First to demonstrate its use in Minnesota
  - MnDOT regular specification used with little change
  - Contractor Plant and paving operations were smooth

- **Benefits**
  - Reduction of mixing and compaction temperatures
  - Compaction aid
  - Future aging reduction
Effect of Drainage on Joint Performance

- **Original Concrete Cells**
  - **Observations – deterioration (high traffic)**
    - None when PASB used
    - Some when Class-5 / well sealed joints / edge drain
    - High amount when Class-5 / no edge drains
  
- **Observations – deterioration (low volume)**
  - If sealed class-5 is not as destructive
  - If not-sealed class-5 can develop joint damage
    
    (Distress occurred with out significant joint faulting)
    (confirmed by similar pavements throughout Minnesota)

- **Benefits**
  - Importance of Drainable bases
  - Importance of joint sealing
  - Effect of Traffic
Open Graded Aggregate Base

- OGAB used at MnROAD
  - Mainline Cell

- Observations
  - First to demonstrate its use in Minnesota
  - MnDOT developed a new specification
  - Drainable and stable for construction
  - Contractor liked

- Benefits
  - Prevention of water damage (HMA - PCC Joints)
  - Improved construction efficiency
Roller compacted Concrete

- **2010 MnROAD Shoulders**
- **Observations**
  - First to demonstrate its use in Minnesota
  - MnDOT special provision – based on other states
  - Contractor liked
  - Material – labor – equipment costs lower
- **Benefits**
  - Shoulder surface
  - Composite pavement lower layer
  - Low Volume Road option
  - Strength of concrete with rapid construction
Future Trends

- Rehabilitation
- Construction Uniformity
- Sustainability
  - Reduce
  - Reuse
  - Recycle
- Surface Characteristics
Proposed Pooled Fund Studies

- Development of an Improved Design Guide for Unbonded Concrete Overlays
  - Solicitation 1309 – Posted Fall 2011
  - Identify suitable interlayer materials
  - Develop M-E design guidelines
  - National Design

- Development and Implementation of Non-Destructive Testing
  - Solicitation 1310 – Posted Fall 2011
  - Research NDT ready for implementation
  - Enhance data analysis and visualization tools
MnROAD By-Pass Rehabilitation Opportunity

- 3 miles of 40 year old concrete
- 2013/2014 District Repairs Planned
- Concrete Condition
  - Very few shattered panels or cracking
  - Poor Load Transfer
  - Rotting Joints
  - ½” up to 1” Faulting (Poor Ride)
  - 4 Concrete Dips
- 2009 Research Project
  - CPR and DBR with Grinding on 1,800 feet
- Best fit for MnROAD?
Proposed Studies

- **What will be MnROAD 3rd Phase?**
  - Current Efforts
    - Working with Research Partners
    - MnDOT
    - LRRB
    - TERRA

- **Continue to Develop Partnerships**
  - Please contact us – we are interested in your input
Thank You

Questions?

5 days till Valentine’s Day