State DOT Members

[Image showing logos of various DOT agencies and a map highlighting states with yellow borders.]
MnROAD Facility

MnROAD

• Full-scale, cold climate pavement test facility near Albertville, MN

• 3.5 mile (5.6 km) “Mainline” section with diverted interstate I-94 traffic

• 2.5 mile (4 km) “Low Volume Road” closed loop test track

• Multiple pavement test sections
  ➢ Asphalt
  ➢ Concrete
  ➢ Overlays

• Operation began in 1994
  ➢ Current conducting Phase 3 experiments (2016 - )

Provides opportunities for BOLD ideas!
• Impacts of Early Loading on Concrete Pavement Performance
  ➢ New pavements
  ➢ Repairs

• Fiber-Reinforced Concrete Pavement
  ➢ Thin slabs on grade

• Compacted Concrete Pavement
  ➢ RCC with a surface texture
Early loading!
Impact of Early Opening to Traffic

Study Objectives

- Evaluate visible and non-visible immediate damage caused by early age loading
- Quantify the effect of early loading damage on long-term performance
- Determine minimum strength at opening or other measurable variables associated with this parameter
- Recommend strategies for minimizing or avoiding early loading damage detrimental to long-term performance
Early Opening to Traffic

- **MnROAD Cells 124-624**
  (Low Volume Road Traffic)
  - Standard panel size 12’W x 15’L
  - Standard concrete mix
  - Doweled joints
  - Early sequential traffic loadings
    - Based on maturity
  - Vehicle driven across concrete before full set to cause visible damage

4/2/2019
Early loading of Cells 124-424

4,000 lb axle vs 14,000 lb axle loads

Credit: Lev Khazanovich, Haoran Li (2019)
Early loading of Cells 124-424

4,000 lb axle vs 14,000 lb axle loads (1st cell loaded @ 3hrs)
Early loading of Cells 124-424

### Loading Plan

#### Cell x24 Early Loading Sequence

<table>
<thead>
<tr>
<th>Maturity (Deg-Hr)</th>
<th>Flexural (psi)</th>
<th>Loads applied to lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>73</td>
<td>1st Load on Cell 124 (forward and back)</td>
</tr>
<tr>
<td>200</td>
<td>196</td>
<td>1st Load on Cell 224, 2nd load on Cell 124</td>
</tr>
<tr>
<td>300</td>
<td>267</td>
<td>1st Load on Cell 324, 2nd load on Cell 224, 3rd load on Cell 124</td>
</tr>
<tr>
<td>400</td>
<td>318</td>
<td>1st Load on Cell 424, 2nd load on Cell 324, 3rd load on Cell 224, 4th load on Cell 124</td>
</tr>
</tbody>
</table>

### Actual Loading

#### Age at Loading (HRS)

<table>
<thead>
<tr>
<th>Paving Time</th>
<th>Loaded Cells</th>
<th>Control</th>
<th>Tire Rut</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>124 IL</td>
<td>224 IL</td>
<td>324 IL</td>
</tr>
<tr>
<td></td>
<td>524 IL</td>
<td>624 IL</td>
<td></td>
</tr>
<tr>
<td>124 OL</td>
<td>224 OL</td>
<td>324 OL</td>
<td>424 OL</td>
</tr>
<tr>
<td></td>
<td>524 OL</td>
<td>624 OL</td>
<td></td>
</tr>
<tr>
<td>12:15</td>
<td>11:15</td>
<td>10:40</td>
<td>9:50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Repetition</th>
<th>Loaded Cells</th>
<th>Control</th>
<th>Tire Rut</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.00</td>
<td>4.00</td>
<td>4.55</td>
</tr>
<tr>
<td>2</td>
<td>4.25</td>
<td>5.25</td>
<td>5.80</td>
</tr>
<tr>
<td>3</td>
<td>6.55</td>
<td>7.55</td>
<td>8.10</td>
</tr>
<tr>
<td>4</td>
<td>8.15</td>
<td>9.15</td>
<td>9.70</td>
</tr>
</tbody>
</table>

Credit: Lev Khazanovich, Haoran Li (2019)
Early loading of Cells 124-424

Dynamic Strain Sensor Data

Credit: Lev Khazanovich, Haoran Li (2019)
Early loading of Cells 124-424

Damage from 4,000 lb axle

Credit: Lev Khazanovich, Haoran Li (2019)
Early Loading of Cell 624

4,000 lb axles @ 2 hrs (very warm day!)

Video of damage loading at 2 hours?
Early Loading of Cell 624

Inside lane

Outside lane
Spring 2019 Cell 624 Condition
Impact of Early Opening on Repairs

- **MnROAD Cells 7 & 8 [Constructed 1993]** (Mainline interstate traffic)
  - Full panel replacements, full-depth joint repairs, and partial-depth repairs
  - Various repair materials
    - MnDOT spec. 3U18M
    - MnDOT spec. 3U58
    - Contractor design high early mix
    - Internal cure mix
    - Roller Compacted Concrete
      - 1 and 2 lifts
  - Early sequential traffic loadings
Cell 7 & 8 Repairs

Repair locations and loading scheme
Cell 7 & 8 Repairs

Partial Depth Repairs
Cell 7 & 8 Repairs

Full Depth Repairs
Cell 7 & 8 Repairs

Internal Cure Mix - High Early Strength
Cell 7 & 8 Repairs

1 and 2 lift RCC (with dowel bars)
Cell 7 & 8 Repairs

Small roller compaction
Cell 7 & 8 Repairs

Early Age Loading
Cell 8 RCC Repair

RCC repair condition - March 2019
Cell 8 Internal Cure Mix Repair

Internal cure mix repair condition - March 2019
Fiber-Reinforced Concrete On Grade

- **MnROAD Cells 506, 606, 706, 806**
  (Mainline interstate traffic)
  
  - All cells: 6’ x 6’ panels
  
  - **Fiber content:**
    - Cell 506: No fibers (control)
    - Cell 606: 20% RSR (ASTM C1609)
    - Cell 706: 30% RSR (ASTM C1609)
    - Cell 806: 0.75% by volume
Cell 506 Control (No fibers)

March 2019 condition: Faulted joints
FRC Cells 506 – 806: Transverse Joint Faulting

Date: 10/03/2018

Faulting (mm)

Joint Number

No fibers (control)  
30% RSR (8 lbs/yd)  
20% RSR (5 lbs/yd)  
0.75% volume (11.7 lbs/yd)

Credit: Manik Barman, Corey Crick (2019)
FRC Cells 506 – 806: Joint Load Transfer Efficiency

- No fibers: 30% RSR (5 lbs/yd) - 0.75% volume (11.7 lbs/yd)
- 20% RSR (5 lbs/yd)
- 30% RSR (8 lbs/yd)
- 0.75% volume (11.7 lbs/yd)

Credit: Manik Barman, Corey Crick (2019)
Early Transverse Joint Deployment

Observation (pavement edge) on 7-5-17, age range: 5 to 9 days, no traffic loads

4/2/2019
Compacted Concrete Pavement

- Scott City, Missouri: Cells 551 – 553
  (Low volume traffic)
  - Cell 551: Control, 550’, 15’Lx12’W panels
  - Cell 552: Short panel, 555’, 12’Lx12’W panels
  - Cell 553: Fiber-reinforced, 280’, 15’Lx12’W panels

- Instrumented by MnROAD staff
- Southbound - Paved 2018
- Northbound – Spring 2019
Missouri CCP Test Sections
Missouri CCP Test Sections
Missouri CCP Test Sections

Broomed Surface
Missouri CCP Test Sections
Questions?

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