Results of MTO’s 2011 Pavement Trials

Alexander W. (Sandy) Brown, P.Eng.
Ontario Hot Mix Producers Association - Technical Director
Asphalt Institute - Canadian Field Engineer
Outline

- Background about SHRP
- Background about Ontario Specifications and industry's partnership with MTO
- Hwy 655 I Trial
- MTO 2011 Acceptance Methodology Trial
Strategic Highway Research Program (SHRP)

- SHRP – 5 year study (1987-1992 with 2 extensions)
  - US Congress established research program to improve highway technology and performance
  - $150 Million in research (plus ~$50 Million)
    - Asphalt
    - Concrete and Structures
    - Highway Operations
    - Pavement Performance

- SHRP Asphalt Research Program
  - Largest SHRP research area ($53 Million)
  - Canadian Contribution (C-SHRP/ Canadian test roads)
Superpave
(Superior Performing Asphalt Pavements)

- Final product of SHRP asphalt research program
- Asphalt Binder Specification
  - Performance Graded Asphalt Cements or PGAC
- Mix design/analysis system based on mix volumetric properties
  - Superpave Mix Design Method
- Mix performance tests and predictive models
  - Not fully implemented
# MTO-Industry Specification Development Partnership Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>Superpave Mix Trials Begin</td>
</tr>
<tr>
<td>1998</td>
<td>PGAC Binders (Switch From Penetration Grade)</td>
</tr>
<tr>
<td>2002</td>
<td>Superpave Mix Design Phase In (30% of MTO Contracts)</td>
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<tr>
<td>2003</td>
<td>Hwy 655 Ph1 Field Trial</td>
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<tr>
<td>2006</td>
<td>Hwy 417 Field Trial</td>
</tr>
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<td>1998</td>
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</tr>
<tr>
<td>2002</td>
<td>Superpave Mix Design Phase In (30% of MTO Contracts)</td>
</tr>
<tr>
<td>2006</td>
<td>Superpave Mix Design Implementation (100% of MTO Contracts)</td>
</tr>
<tr>
<td>2007</td>
<td>Hwy 655 Ph 2 Field Trial</td>
</tr>
<tr>
<td>2008</td>
<td>Hwy 427 Field Trial</td>
</tr>
<tr>
<td>2011</td>
<td>Acceptance Methodology Pavement Trial (First Projects Constructed)</td>
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<tr>
<td>2015</td>
<td>Tightened Tolerances on Ash, DENT</td>
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<tr>
<td>2008</td>
<td>PPA Limits</td>
</tr>
<tr>
<td>2011</td>
<td>Acceptance Methodology Pavement Trial (First Projects Constructed)</td>
</tr>
<tr>
<td>2012</td>
<td>Enhanced Specification MSCR % Recovery, DENT, Ash Tests</td>
</tr>
<tr>
<td>2015</td>
<td>Tightened Tolerances on Ash, DENT</td>
</tr>
</tbody>
</table>

**MTO’s transition from Marshall to Superpave Mix Design results in mixes with reduced AC contents**

**Most municipalities did not adopt MTO specification enhancements in 2008/2012**
## Pavement Trials and Performance Studies

<table>
<thead>
<tr>
<th>Trial / Study</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway 655 – Phase 1</td>
<td>2003</td>
<td>6 trial sections</td>
</tr>
<tr>
<td>Highway 417</td>
<td>2006</td>
<td>7 trial sections</td>
</tr>
<tr>
<td>Highway 655 – Phase 2</td>
<td>2007</td>
<td>8 trial sections</td>
</tr>
<tr>
<td>Highway 427</td>
<td>2008</td>
<td>5 trial sections (over concrete)</td>
</tr>
<tr>
<td>Analysis of Pavement Performance in Eastern and Northeastern Ontario</td>
<td>2009 Study on Regional MTO Pavements</td>
<td>20 pavements</td>
</tr>
<tr>
<td>Acceptance Method Pavement Trial</td>
<td>2011-2015</td>
<td>38 trial sections</td>
</tr>
</tbody>
</table>
Performance of PG \( xx-34 \) Binders in a PG \( xx-40 \) Zone
MTO Hwy 655 Ph1 Field Trial (Timmins, 2003)

Timmins requires PG \( xx-40 \) binder at a 98% reliability level (87% at -34°C).
- Hwy 655 Trial used PG \( xx-34 \) binders.
- Pavement temperature fell below -34°C and contributed to cracking.

Cracking in Hwy 655 Ph1 sections was not unexpected.

2009 CTAA Paper co-authored by Huber (Heritage), Marks (MTO), Brown (OHMPA), and Raymond (MTO) recommends that ExBBR findings be validated in Hwy 655 Ph2 trial constructed in 2008.
- This remains outstanding and needs to be completed.

Actual Pavement Temperature calculated from air temperature and is reported in 2009 CTAA paper co-authored by Huber, Marks, Brown, and Raymond.

April 28, 2015
Comparable cracking between binder specifications when outliers are accounted for
- Low temp grade does not match climatic requirement
- Mill + Pave 1 over heavy AADT

One of best performers had low temp (1 hr BBR) improved by one grade
- Did not meet ExBBR, DENT, MSCR % Recovery
- Pulverize + Pave 3

2011-4033
Pulverize + Pave 3
Rejectable LTLG
Major Borderline DENT
Rejectable MSCR % Rec

2011-2015
Should be a PG xx-34

2011-5104: Mill + Pave 3
LTLG Major and Minor Borderline

2011-2016
Should be a PG xx-34

2011-5121
Should be a PG xx-40

AADT = 159,000

2011-2018: Mill + Pave 1
LTLG Minor Borderline

2011-2022
Should be a PG xx-34

2011-2023
Should be a PG xx-34

2011-5104
Should be a PG xx-40

2011-5121
Should be a PG xx-40

Improve Low Temp (1 hr BBR) PG By One Grade

Comparable cracking between binder specifications when outliers are accounted for
- Low temp grade does not match climatic requirement
- Mill + Pave 1 over heavy AADT

One of best performers had low temp (1 hr BBR) improved by one grade
- Did not meet ExBBR, DENT, MSCR % Recovery
- Pulverize + Pave 3

2011-4033
Pulverize + Pave 3
Rejectable LTLG
Major Borderline DENT
Rejectable MSCR % Rec
Construction type influences cracking

- Best performers
  - Pulverize + Pave 3
  - FDR + Pave 2
  - CIREAM + Pave 2

Overlay
Pulverize
Mill
FDR
CIREAM

1 lift
2 lifts
3 lifts

Filled symbols indicate LTPP grade is 6C lower than specified grade

April 28, 2015
Poor Correlation (trending correctly)

Results of MTO ARAN Cracking Measurement at 3 years

Filled symbols indicate LTPP grade is 6C lower than specified grade

\[ y = 19.5x + 197.01 \]
\[ R^2 = 0.2232 \]
Moderate Correlation (trending correctly)
Results of MTO ARAN Cracking Measurement at 3 years

\[ y = 38.378x + 350.69 \]
\[ R^2 = 0.4888 \]

Filled symbols indicate LTTP grade is 6°C lower than specified grade

\( \text{Overlay, Pulverize, Mill, FDR, CIREAM} \)

1, 2, 3 - HMA lifts

Specified M320 (1 hr BBR) Difference (°C) measured by MTO QA testing
No Correlation (no trend)
Results of MTO ARAN Cracking Measurement at 3 years

\[ y = 2.0989x + 241.97 \quad R^2 = 0.003 \]

\[ y = -6.6745x + 245.3 \quad R^2 = 0.0068 \]
No Correlation (trending incorrectly)

Results of MTO ARAN Cracking Measurement at 3 years
Total Cracking with Proper LTPPBind Grade

\[ y = -20.82x + 156.94 \quad R^2 = 0.0269 \]

\[ y = -21.256x + 248.09 \quad R^2 = 0.0653 \]

- LTLG - 72 hr ExBBR
- M320 - 1 hr BBR

Difference from Specified Value (°C)
measured by MTO QA testing
No Correlation (trending incorrectly)

Results of MTO ARAN Cracking Measurement at 3 years

Filled symbols indicate LTPP grade is 6°C lower than specified grade

\[ y = 304.37e^{0.0964x} \]

\[ R^2 = 0.0425 \]
No Correlation (trending incorrectly)
Results of MTO ARAN Cracking Measurement at 3 years

Filled symbols indicate LTPP grade is 6C lower than specified grade

\[ y = 324.91 e^{-2.135x} \]
\[ R^2 = 0.2337 \]
Poor Correlation (trending correctly)
Results of MTO ARAN Cracking Measurement at 3 years

Overlay
Pulverize
Mill
FDR
CIREAM

1, 2, 3 - HMA lifts

Filled symbols indicate LTPP grade is 6C lower than specified grade

\[ y = 285.22e^{-0.013x} \]
\[
R^2 = 0.1332
\]

MSCR Recovery Difference from Curve (%) measured by MTO QA testing
No Correlation (trending incorrectly)
Results of MTO ARAN Cracking Measurement at 3 years

1, 2, 3 - HMA lifts
Filled symbols indicate LTPP grade is 6C lower than specified grade

\[ y = 204.96e^{0.0503x} \]
\[ R^2 = 0.1683 \]
Summary of the crack monitoring at 3 years based on MTO monitoring and testing

- The standard 1 hr BBR test shows better correlation than 72 hr Extended BBR test
- Loss doesn’t correlate – engineering control
  - Asking for DENT or MSCR seemed to control Loss
- Ash (REOB) doesn’t correlate – engineering control
- MSCR has poor correlation (trends correctly)
- DENT doesn’t correlate (trends incorrectly)

- These charts will change – it's only been three years