Ontario’s Experience with WMA

2nd International Warm-Mix Conference
St. Louis, Missouri
October 11-13, 2011

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Materials Engineering and Research Office
Ministry of Transportation of Ontario (MTO)
Overview

• MTO Strategic Directions 2010-2015
• WMA Definition
• Benefits of WMA
• Challenges of WMA
• MTO WMA Trials
• Additional Requirements for 2010 Contracts
• Test Results Summary
• WMA Task Group
• MTO’s Vision for 2011
• WMA Requirements for 2011 Contracts
• Closing Remarks
MTO Strategic Directions 2010 - 2015

1. A provincial expansion plan developed in collaboration with Policy & Planning Division.
2. A strengthened policy capability to influence ministry and government activities in support of division initiatives.
3. A workforce that is poised to meet our changing business directions.
4. The greenest roads in North America.
5. A quarter of our business delivered in innovative and improved ways.
6. Seventy-five cents of every construction dollar spent directly on pavements and bridges.
7. In collaboration with industry, develop performance-based specifications for all contracts.
WMA Definition

MTO adopted NAPA’s Definition of WMA

- A group of technologies which allow a reduction in the temperatures at which asphalt mixtures are produced and placed. WMA can be separated into 3 categories:
  - Chemical Processes
  - Organic Additives
  - Foaming Processes (water-bearing additives or water-based processes)
- WMA allows compaction temperature to be reduced by 20-50°C while still achieving adequate compaction
Benefits of WMA

Comparing to HMA, WMA has the following benefits:

- Reduces energy (fuel) consumption
- Reduces asphalt plant emissions
- Reduces paving crew exposure to emissions
- Improves compaction and joint quality
- Facilitates late season paving due to increased workability
- Reduces asphalt binder aging (less potential for cracking)
- Facilitates longer hauling distances
- Allows for earlier opening to traffic after construction
- Potential for higher RAP content
Challenges of WMA

• Costs?
• Lack of knowledge/experience with WMA
• Effectiveness of different technologies – not all are the same
• Ensuring long term performance including moisture susceptibility
• Mix design procedure
• Recyclability
• Restrictions/adjustments at the asphalt plant
MTO WMA Trials

- Since 2008, about 70,000 tonnes of WMA has been paved in 15 MTO contracts
- 2008 - 1 trial contract and 2 “change proposals”
- 2009 - 2 contractor change proposals
- 2010 - 9 trial contracts and 1 change proposal
- WMA specifications were developed in 2009 for
  - WMA trials
  - Optional WMA (contractor has an option to bid for WMA)
## 2010 WMA Trials

<table>
<thead>
<tr>
<th>Contract #</th>
<th>WMA Mix Type</th>
<th>PGAC</th>
<th>WMA Additive</th>
<th>Asphalt Plant Type/Burner Type</th>
<th>Fuel Type</th>
<th>Date of Paving</th>
<th>HMA Control Section?</th>
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<tr>
<td>1</td>
<td>SUP 12.5FC 2</td>
<td>64-28</td>
<td>Hypertherm (chemical)</td>
<td>Drum plant - Not open flame burner</td>
<td>Natural Gas</td>
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<td>3</td>
<td>SUP 12.5FC 1</td>
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<td>Hypertherm (chemical)</td>
<td>Batch plant - counter-flow drum burner</td>
<td>Natural Gas</td>
<td>September 2010</td>
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<td>4</td>
<td>SUP 12.5FC 1</td>
<td>58-34</td>
<td>Evotherm 3G (chemical)</td>
<td>Batch plant</td>
<td>Diesel</td>
<td>July 2010</td>
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<td>Evotherm DAT (chemical)</td>
<td>Drum plant</td>
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<td>Batch plant - Forced draft burner</td>
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</tbody>
</table>

FC 1 = coarse aggregates must be supplied from a premium source; FC 2 = fine and coarse aggregates must be supplied from a premium source
Stack emissions testing

Asphalt fumes monitoring

No visible fumes

RAP
Additional Requirements for 2010 Contracts

- WMA suppliers’ Recommendations
- One point mix design check (for most technologies)
- Maximum paving temperature (125 °C)
- Emissions testing
  - Testing at the asphalt plant
  - Testing on the job site (workers exposure)
- Mixing and paving temperature data
- TSR on the production samples
- Additional samples of HMA/WMA for Hamburg Test
- WMA paving limits (Station + GPS)
Emissions Testing Requirements

• Testing at asphalt plant:
  • CO, CO₂, NOₓ, SOₓ, VOC & TPM
  • single 224 minute particulate test at the baghouse exhaust stack
  • triplicate 60 minute emission tests for combustion gases
• Testing at the paving site (workers exposure):
  • 5 hours of opacity and industrial hygiene sampling for total dust and benzene soluble fraction during paving
  • Monitors installed on the operator of the paver and one worker at the rear of the paver
• Measurements for both HMA and WMA
# End Result Specification (ERS) Data

<table>
<thead>
<tr>
<th>Contract</th>
<th>Mix Type</th>
<th>AC Content (Lot Avg.)</th>
<th>Compaction (Lot Avg.)</th>
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<td>JMF</td>
<td>HMA</td>
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<tr>
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<td>4.7</td>
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## Moisture Sensitivity Testing (AASHTO T283)

| Contract | Mix Type   | Mix Design TSR | Production TSR       |
|==========|------------|----------------|----------------------|
| 1        | SUP12.5FC 2| 80             | 90 – 96 (92)         |
| 2        | SUP12.5FC 2| 80             | 87 – 88 (87)         |
| 3        | SUP12.5FC 1| 81             | 74 – 88 (82)         |
| 4        | SUP12.5FC 1| 84             | 44 – 90 (73)         |
| 5        | SUP12.5    | 81             | 63 – 73 (67)         |
| 6        | SUP12.5    | 82             | 59 – 99 (78)         |
| 7        | SUP12.5    | 96             | 76 – 94 (86)         |
| 8        | SUP12.5    | 81             | 81 – 86 (83)         |
| 9        | SUP12.5FC 1| 92             | 84 – 117 (97)        |

Numbers in parentheses denote mean value
Hamburg Wheel Track Testing (Modified)

The test is used to evaluate the rutting/stripping potential of various asphalt mixes including WMA

Specimen Preparation
- 4 briquettes are compacted by SGC at 6-8% voids using loose asphalt mix
- Briquettes are cut and fit into 2 metal moulds

Testing
- Moulds are submerged in 60°C water bath
- Test is run for 20,000 load applications (6 hours)
- Load is applied via pneumatic tires
## Hamburg Test Results

<table>
<thead>
<tr>
<th>Contract</th>
<th>Mix Type</th>
<th>PGAC</th>
<th>WMA Technology</th>
<th>Max. Rut Depth (mm)</th>
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<tbody>
<tr>
<td>1</td>
<td>SUP 12.5FC 2</td>
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<td>Hypertherm</td>
<td>HMA: 7.9, WMA: 5.7</td>
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<tr>
<td>2</td>
<td>SUP 12.5FC 2</td>
<td>64-28</td>
<td>Hypertherm</td>
<td>HMA: 5.3, WMA: 5.0</td>
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<tr>
<td>3</td>
<td>SUP 12.5FC 1</td>
<td>64-28</td>
<td>Hypertherm</td>
<td>HMA: 1.3, WMA: 1.9</td>
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<tr>
<td>4</td>
<td>SUP 12.5FC 1</td>
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<td>Evotherm 3G</td>
<td>HMA: N/A, WMA: 7.5</td>
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<td>5</td>
<td>SUP 12.5</td>
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<td>Evotherm DAT</td>
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<td>Evotherm 3G</td>
<td>HMA: 4.9, WMA: 5.0</td>
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<td>Evotherm 3G</td>
<td>HMA: 1.5, WMA: 3.4</td>
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<td>Evotherm 3G</td>
<td>HMA: 1.8, WMA: 3.2</td>
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<td>Evotherm 3G</td>
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<td>Sasobit</td>
<td>HMA: 2.0, WMA: 1.7</td>
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# Temperature Data for WMA

<table>
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<tr>
<th>Contract</th>
<th>Mixing Temp (°C)</th>
<th>Paving Temp (°C)</th>
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WMA Emissions Testing Results

CO2 Emission Comparison

CO Emission Comparison

Materials Engineering and Research Office
WMA Emissions Testing Results

**NOx Emission Comparison**

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**SO2 Emission Comparison**

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WMA Emissions Testing Results

VOC Emission Comparison

Particulates Emission Comparison
WMA Emissions Testing Summary

- Asphalt plant emissions were not significantly different, although slightly lower for WMA
- At the paving site:
  - Benzene soluble fraction and visible emissions were significantly lower for WMA
  - The results for total dust were inconclusive
2010 WMA Trials Summary

- WMA was paved at temperatures 10-30°C lower than HMA without any adverse effect on mix properties or compaction
- TSR results for WMA were significantly variable with values ranging from 44 to 117 percent
- In general, the average ERS compaction results for WMA was either equal or better than HMA
- All the PGAC samples were in compliance with AASHTO M320 for both HMA and WMA
- Hamburg rut depths were comparable between WMA and HMA
WMA Task Group

First WMA Task Group meeting was held on Nov 12, 2010

Rationale

• WMA is a rapidly growing technology
• Leverage the experience of others and deal with challenges in an equitable manner

Members

• MTO
• Ontario Hot Mix Producers Association
• Ontario Good Roads Association
WMA Task Group

Objectives
- Develop framework, identify focus areas and timetable for the TG
- Compile a WMA state of the practice guide
- Adopt mix design procedures for various WMA technologies
- Establish contractor guidelines for WMA use
- Incorporate feedback from WMA suppliers
- Develop educational materials to promote WMA
- Provide recommendations to improve current WMA specification

Sub-groups
- Mix Design Sub-Group
- Contractor’s Sub-Group
- WMA Supplier’s Sub-Group
- Education Sub-Group
MTO’s Vision for 2011

• Past WMA trials have been successful and support increased WMA usage
• MTO has targeted 10% WMA use in 2011 on contracts meeting either of the following criteria:
  • Contracts for which late-season paving is anticipated
  • Multilane highways where operational constraints prevent echelon paving
  • Projects within urban areas where emissions reduction is of greatest benefit
  • Contracts where long haul distances are expected
  • Asphalt overlay on a pavement with sealed cracks
• WMA will be included in larger tonnage contracts than in previous years
• WMA is to be used in surface and binder course layers
• A comprehensive performance monitoring program will be developed for WMA trials
WMA Requirements for 2011 Contracts

• Superpave mix design according to Draft LS-318
  • Flow Number in accordance with AASHTO TP79 (for info only)
  • Coating test in accordance with AASHTO T195 (for info only)
  • Compactability test as described in LS-318 (for info only)
  • Minimum TSR of 0.8 is required
  • For completed HMA designs “temperature bracketing” is needed to confirm WMA volumetrics

• TSR on the production samples performed by QA lab (for info only)

• WMA suppliers’ Recommendations

• Contractors are encouraged to record the fuel usage at the asphalt plant during WMA/HMA production
Closing Remarks

• WMA is an innovative green technology that supports our strategic directions

• MTO will continue to work with WMA Task Group to investigate WMA and improve our WMA specification

• Given the environmental benefits and potential performance improvements, the life cycle cost of WMA is expected to be similar to HMA

• By targeting WMA use on 10% of 2011 contracts, MTO is demonstrating leadership with this technology and providing asphalt industry the opportunity to invest and build confidence in WMA

• Many agencies in North America, including MTO, have been successful with WMA and intend to increase WMA usage in future
Thank You

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