Warm-Mix Asphalt for Airfield Pavements: The US Army Corps of Engineers Work

Mariely Mejías-Santiago
Engineer Research and Development Center
Vicksburg, MS

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Outline

• Background
• Objectives
• Approach
• Laboratory Work
• Field Work
• Conclusions
• Recommendations
• Questions
Background

- WMA is quickly becoming common practice in many state DOTs
- Good performance
- More than 20 technologies in U.S.
- At least 10 states have adopted its use
- Mostly highways
• Need guidance for use of WMA on airfields
• Airfield projects:
  ▪ South America, South Africa and Europe
  ▪ United States:
    ▪ Logan Intl. Airport, Boston
    ▪ Elmendorf AFB and Anchorage Airport, Alaska
### Background (cont.)

**Highways vs. Airfields**

<table>
<thead>
<tr>
<th>18 wheeler</th>
<th>F-15 Eagle</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 psi</td>
<td>325 psi</td>
</tr>
<tr>
<td>4,500 lb</td>
<td>35,000 lb</td>
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</tbody>
</table>
Research Objectives

Part I. Evaluate laboratory performance:
- WMA
- WMA+RAP
- Moisture susceptibility study
- Develop guidance for WMA for airfields

Part II. Evaluate field performance:
- Field performance under aircraft loading
- Lab performance of plant-produced WMA mixes
- Modify guidance as needed
Research Approach

- Warm-Mix Asphalt Evaluation
  - Lab Performance
    - Lab-Produced Mixes
    - Guide Specifications for Airfields
  - Plant-Produced Mixes
  - Full-Scale Test Sections
    - Field Performance
      - Modify Guide Specifications for Airfields
Laboratory Performance of WMA
Laboratory Performance of WMA

Moisture Damage Study

- **WMA technologies:**
  - Sasobit® - 1.5%
  - Evotherm™ - 0.5%
  - Foamed Asphalt - 2%
- **Aggregates:**
  - gravel – 1% hydrated lime
  - limestone
- **PG 67-22**
Laboratory Performance of WMA

Moisture Damage Study

- Mixing temperatures:
  - Low: 265 °F
  - Intermediate: 295 °F
  - High: 320 °F
- RAP
  - 0%
  - 25%
  - 50%
- TSR criterion – 0.75
Laboratory Performance of WMA
Moisture Damage Study
Limestone Mixes

- **Dry Tensile Strength, psi**
- **Wet Tensile Strength, psi**
- **TSR**

**Temperatures:**
- 265 °F
- 295 °F
- 320 °F
Laboratory Performance of WMA
Moisture Damage Study
Limestone Mixes + 50% RAP

Graph showing tensile strength (psi) for Sasobit, Foamed, and Elotherm mixes at 265°F, 295°F, and 320°F. The graph compares dry tensile strength in red, wet tensile strength in blue, and TSR in green. The tensile strength values range from 0 to 700 psi, and the TSR values range from 0 to 1.20.
Laboratory Performance of WMA Moisture Damage Study
Gravel Mixes

![Graph showing tensile strength at different temperatures and materials](image)
Laboratory Performance of WMA
Gravel/Foamed Asphalt 0% RAP
Laboratory Performance of WMA
Moisture Damage Study
Gravel Mixes + 50 % RAP

Tensile Strength (psi)

Dry Tensile Strength, psi
Wet Tensile Strength, psi
TSR

265 °F
295 °F
320 °F

Sasobit, Foamed, Evotherm
Sasobit, Foamed, Evotherm
Sasobit, Foamed, Evotherm, HMA

BUILDING STRONG®
Laboratory Performance of WMA

- WMA:
  - produces slightly lower high temperature properties
  - slightly lower rutting resistance
  - does not affect low temperature properties significantly
  - should not affect low-temperature cracking

<table>
<thead>
<tr>
<th>Mixture Type</th>
<th>Total Asphalt Content (%)</th>
<th>Pass / Fail Temperature (°C)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>HMA</td>
<td>4.7</td>
<td>73</td>
</tr>
<tr>
<td>Sasobit</td>
<td>4.8</td>
<td>70</td>
</tr>
<tr>
<td>Evotherm</td>
<td>4.7</td>
<td>66</td>
</tr>
<tr>
<td>Foamed Asphalt</td>
<td>5.2</td>
<td>69</td>
</tr>
</tbody>
</table>
Laboratory Performance of WMA

- WMA + high RAP:
  - High temperature properties increased by 16 degrees
    - Significant increase in rutting resistance
  - Low temperature properties increased by 6 degrees
    - Slight increase in susceptibility to low-temperature cracking
Field Performance of WMA
Field Performance of WMA

- Four different mixes:
  - Sasobit®
  - Evotherm™
  - Foamed Asphalt
  - Control - HMA
- F-15E loading – HVS temperature-controlled
- Failure: 1 in. rut depth
Field Performance of WMA

- Laboratory testing of plant-produced mixes
  - Moisture Susceptibility – TSR Test
  - Rutting – APA Test:
    - Hose pressure: 250 psi
    - Temperature: 67 °C
    - Wheel Load: 250 lb
Conclusions

• Moisture damage study:
  ▪ Gravel WMA mixes showed moisture susceptibility for lower mixing temperatures. Limestone mixes did not show this problem.
  ▪ WMA additive type did not significantly affect moisture susceptibility at HMA mixing temperature.
  ▪ The low mixing temperature results in increased moisture susceptibility of WMA for some WMA additives/processes
  ▪ Increasing RAP tended to increase resistance to moisture susceptibility.
Conclusions

- **WMA technology + high RAP content:**
  - improved rutting resistance as shown by increase of 16 in high PG grade
  - some potential increase in susceptibility to thermal cracking as a result of increase of 6 in low PG grade
  - increase in high PG grade (16) is clearly higher than the increase in low PG grade (6)
  - field projects have not shown significant differences in performance between WMA with high RAP and conventional HMA
Recommendations

- WMA has been used on a few airfield pavements with success and this use is expected to grow very rapidly.

- Each Major Command should consider constructing at least 1 WMA project each year to begin developing performance data and expertise with these products.

- Performance data from field testing and lab testing on plant-produced mixes will help refine the current guide specifications.

- The use of high percentages of RAP with WMA looks promising and should be considered for selected field projects if additional research supports this effort.
Acknowledgements

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Questions