AASHTO Subcommittee on Materials
Recycled Engine Oil Task Force
Report to SOM

William Ahearn P.E., VTrans
August 2, 2015 SOM Meeting
"REOB or VTAE" from Used Oil
Charge - SOM REOB Task Force

• Past, current and upcoming research regarding the use of REOB in pavements including scope and timing of research
• Status of use of REOB in asphalt across State DOTs, including knowledge of presence, pertinent specifications for use, including certification or specification requirements
• Best practices for determining the presence and amounts of REOB in pavements
Charge - SOM REOB Task Force

• Describe recommended additional research to fully evaluate the allowance of REOB into asphalt pavements, or mitigation of its use if necessary

• Preliminary risk assessment of member State’s asphalt binder specifications and associated recommendations
Hamburg Wheel Test

courtesy MADOT
Hamburg Results: ARGG Plant Produced Mixture Delivered 10-7-14
Mixture Provided by MassDOT

MassDOT Criteria
1. A maximum rut depth of 12.5 mm at 20,000 passes for HMA and WMA.
2. No abrupt increase in the rate of deformation (Stripping Inflection Point) prior to 15,000 passes.

<table>
<thead>
<tr>
<th>Plant Mix ARGG 9-15-14</th>
<th>Plant Mix ARGG 10-6-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Air Voids: 8.02%</td>
<td>Average Air Voids: 8.92%</td>
</tr>
<tr>
<td>Test Temperature: 50°C</td>
<td>Test Temperature: 50°C</td>
</tr>
<tr>
<td>Stripping Inflection Point: 15,400</td>
<td>Stripping Inflection Point: 10,700</td>
</tr>
<tr>
<td>Rut Depth at 10,000: 2.95 mm</td>
<td>Rut Depth at 10,000: 10.54 mm</td>
</tr>
<tr>
<td>Rut Depth at 20,000: 8.81 mm</td>
<td>Rut Depth at 13,963: 20.08 mm</td>
</tr>
</tbody>
</table>
Past, Current and Upcoming Research

• REOB specific research is sparse – in the dozens of articles.
• However many relevant articles are available that address asphalt aging and hardening.
• TF examined research from a range of opinions to develop an outline of the knowledge
  – Industry sponsored research confirms that there can be a binder grading change from REOB in specific cases
  – REOB has been in use for 25 years or more, with ongoing manufacturing changes
Past, Current and Upcoming Research

- Introducing REOB introduces risk. The percent allowable is unknown and depends on the chemistry of the REOB and the Asphalt.
- Limited studies on mixture and binder indicate that low replacement levels of REOB can result in binder and mixture that pass PG Binder laboratory tests.
- Field performance issues are documented that strongly imply REOB contributed to lower life expectancy.
VT
I 89 Middlesex, VT
loss of mastic, erosion through surface 5 yr
ME
US Route 1A, Holden, ME
Loss of mastic, raveling
7 yr
Status of use of REOB

• Based on survey results 20 states have received REOB of the 43 respondents*, based on FHWA test results 18 states of 37 tested had REOB present
• Nearly half the states received REOB modified PG Binders
• States were informed by:
  – Suppliers 29% **
  – FHWA test results 64%
  – I/E test results 29%
Status of use of REOB

• State specifications and expectations:
  • Specific approval 2%
  • Conditional Approval 5%
  • Prohibit 22%
  • Silent – use general PG standards 71%
• Most states consider REOB a modifier of asphalt binder.
• Industry has not uniformly reported REOB as a modifier.
Status of use of REOB

• Industry has not uniformly reported REOB as a modifier.
• Resellers make (further) modifications to meet State’s requirements or specifications without knowledge of prior modifications.
• Modifiers can interact or confound detection requiring a suite of testing to identify materials.
Available techniques - REOB

• Asphalts with REOB have higher **Ash** content, up to 3% in modified vs. 0.2% in neat binders - respectively.

• **X-ray Fluorescence** analysis provides semi-quantitative results based on metals content. XRF may reveal additional modifiers including Ground Tire Rubber (GTR).

• Modifiers including VTAE (a product that will include REOB) may not be quantifiable by metals content analysis in the future.

• Proxy tests that limit mechanical properties
Field Performance - No REOB

11 year old- taken in 2014

Highway 655, Timmins, Ontario
- Two lifts to make 90mm over granular base
- Estimate 0% REOB based on XRF and FTIR testing
- Performing well and largely free of distresses
- Centerline joint and shoulders are beginning to crack after 11 years.
Field Performance - REOB

Highway 655, Timmins, Ontario

- Two lifts to make 90 mm over granular base
- Estimate 9% REOB based on XRF and FTIR testing
- Severe alligator cracking since 5 years old
- Transverse cracks sprouting from wheel path and longitudinal joint
Is your state involved in REOB research?

- State Staff Led: 23.1%
- University Led: 12.8%
- No Research: 64.1%
Recommended additional research

• States are relying on national scale study to help with this issue

• Introduce REOB study into ongoing NCHRP studies with additional funding if necessary

• Compile an expanded data set for REOB test results to accurately describe REOB
Recommended additional research

- Endorse and fully support existing efforts:
  - “The Impacts on Pavement Performance from Changes in Asphalt Production” proposed NCHRP
  - Proposed NCHRP synthesis “Relationship between Chemical Makeup of Binders and Engineering Performance” will help
  - Initiatives in application of complex factor assessment of asphalt performance including Glover-Rowe parameter; changes in performance criteria such as m, S; crossover temperature (from earlier SHRP I work) that focus on embrittlement and relaxation
  - NCHRP studies assessing failure mechanisms with emphasis on service life to onset failure
VT
US 2 Montpelier
Raveling through surface course, loss of mastic 5yrs
Preliminary risk assessment

• A common interpretation of modifiers under AASHTO specs is needed, especially with industry for transparency (see M320 5.1, 5.2)

• Interim action is needed to address premature failure from REOB using binder and mix tests
  — Surrogates —
  • Double Edge Notch Tension (DENT)
  • Direct tension testing (DTT)
  • Ductility testing
  • Circular Bend Test (SCB)
Preliminary risk assessment

– When added as a less expensive extender, REOB has diluted asphalt with implied field performance issues
– Modifiers for PG asphalt are rapidly evolving as well as changes in base asphalt qualities. These factors pose significant risk to the durability of pavements.
– Recycled materials necessitate more modifiers so increasing issues are expected
– **Implement a standard practice for approval of modifiers with an updated standard**
Benefit and Value – fractional cost increases for quality

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Type</th>
<th>Total Construction Costs</th>
<th>Bituminous Material Costs</th>
<th>AC Costs</th>
<th>AC Costs as Percent of Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>All Projects 2014</td>
<td>$1.8 B</td>
<td>$458 M</td>
<td>$207 M</td>
<td>11.5%</td>
</tr>
<tr>
<td>VT</td>
<td>All Projects 2012</td>
<td>$163 M</td>
<td>$31.6 M</td>
<td>$10.5 M</td>
<td>6.45%</td>
</tr>
</tbody>
</table>
## SOM REOB Task Force

<table>
<thead>
<tr>
<th>Michael San Angelo AK</th>
<th>Richard Bradbury ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matthew Mueller IL</td>
<td>Christopher Abadie LA</td>
</tr>
<tr>
<td>John Grieco MA</td>
<td>Christopher Peoples NC</td>
</tr>
<tr>
<td>Eileen Sheehy NJ</td>
<td>Becca Lane ON Province</td>
</tr>
<tr>
<td>Terry Arnold FHWA</td>
<td>Matthew Corrigan FHWA</td>
</tr>
<tr>
<td>Nelson Gibson FHWA</td>
<td>William Ahearn VT</td>
</tr>
</tbody>
</table>