REOB Activities

• Chemistry Laboratory
  – How can I detect it and how much is there?

• Binder Rheological Laboratory
  – How can you make other grades with it?
  – What might be the most REOB that can fit into a binder?

• Asphalt Mixtures Laboratory
  – For like PG grades, what are the net-effect consequences? If any?
    • Stripping / Moisture Damage
    • Low Temperature Cracking
    • Permanent Deformation
    • Aging Susceptibility / Fatigue Cracking

• Accelerated Load Facility – PG58-28 Binder Contain REOB
Discussions Held & Work Plan Vetted

• Illinois DOT
• Crystal Clean
• Safety Clean
• 6 New England DOTs
Two Modification Approaches

- Softening an unmodified PG to another PG

  PG70-22
  ↓
  PG64-22 / PG64-28?
  ↓
  PG58-28?

  PG64-22
  ↓
  PG58-28
Two Modification Approaches

- Softening an unmodified PG to another PG
  - PG70-22
  - PG64-22
  - PG64-22 / PG64-28?
  - PG58-28?
  - PG64-22
  - PG58-28

- Diluting a unmodified PG
  - PG64-22
  - "pitch" + REOB
  - PG58-28
  - PG58-28
Two Modification Approaches

- Softening an unmodified PG to another PG
  - PG70-22
  - PG64-22 / PG64-28?
  - PG58-28?
  - PG64-22
  - PG58-28

- Diluting a unmodified PG
  - PG70-22
  - PG64-22
  - PG58-28
Softening ALF PG70-22
Softening BP 64-22
Stiffening & then Softening 58-22
### Results

<table>
<thead>
<tr>
<th></th>
<th>% Pitch</th>
<th>% REOB1</th>
<th>%REOB2</th>
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</thead>
<tbody>
<tr>
<td>PG58-28 Holly Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PG58-28</td>
<td>16</td>
<td>20</td>
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<tr>
<td>PG46-28</td>
<td>16</td>
<td>0</td>
<td>20</td>
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<td>PG70-22 2002 ALF</td>
<td>0</td>
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<td>0</td>
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<td>PG58-28</td>
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<td>14.5</td>
<td>0</td>
</tr>
<tr>
<td>PG58-34</td>
<td>0</td>
<td>0</td>
<td>14.5</td>
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<tr>
<td>PG64-22 British Petroleum</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PG58-28</td>
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<td>9.8</td>
<td>0</td>
</tr>
<tr>
<td>PG58-28</td>
<td>0</td>
<td>0</td>
<td>9.8</td>
</tr>
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</table>
Selection of Binders for Mixture Tests

1. PG58-28 “Control”; 0% REOB
   - Holly Frontier – Confirmed 0% REOB

1. PG58-28 “Moderate/Typical”; 3-6% REOB
   - British Petroleum PG64-22 Base
     And / Or
   - ALF PG58-28

2. PG58-28 “Large m&S $\Delta T$”; High REOB+Pitch
   - Holly Frontier Base
Planned Mixtures’ Experimental Design

- **“Moisture Damage”**
  - Granite- Occoquan VA
  - Tensile Strength Retained TSR; ***<3-5 F-T cycles
  - Hamburg Wheel Tracking
  - Repeated With & Without Hydrated Lime

- **“Structural Performance”**
  - ALF 22% RAP Mix
  - Flow Number; confined NCHRP 9-30A
  - TSRST
  - Dynamic Modulus, |E*|
  - Uniaxial Fatigue @ Short and Long-Term Aged (loose mix 5 days @ 85°C)

Completion Projected by Dec 2014 – Jan 2015
## ALF Experimental Design

<table>
<thead>
<tr>
<th>Production Temperature</th>
<th>300°F - 320°F</th>
<th>240°F - 270°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-</td>
<td>Foam</td>
</tr>
<tr>
<td>Recycle Content</td>
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<td>Chem.</td>
</tr>
<tr>
<td>0%</td>
<td>PG64-22</td>
<td>-</td>
</tr>
<tr>
<td>20% ABR RAP</td>
<td>PG64-22</td>
<td>PG64-22</td>
</tr>
<tr>
<td>≈ 23% by weight</td>
<td>PG64-22</td>
<td>PG64-22</td>
</tr>
<tr>
<td>20% ABR RAS</td>
<td>PG64-22</td>
<td>PG58-28</td>
</tr>
<tr>
<td>≈ 6% Shingle by weight</td>
<td>PG58-28</td>
<td>PG58-28</td>
</tr>
<tr>
<td>40% ABR RAP</td>
<td>PG64-22</td>
<td>PG58-28</td>
</tr>
<tr>
<td>≈ 44% by weight</td>
<td>PG58-28</td>
<td>PG58-28</td>
</tr>
</tbody>
</table>
## ALF Experimental Design

### HMA / WMA Production Temperature

<table>
<thead>
<tr>
<th>Warm Mix Technology</th>
<th>Recycle Content</th>
<th>300°F - 320°F</th>
<th>240°F - 270°F</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>-</td>
<td>Foam</td>
</tr>
<tr>
<td></td>
<td>20% ABR RAP ≈ 23% by weight</td>
<td>✔ PG64-22</td>
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</tr>
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<tr>
<td></td>
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<td>✔ PG58-28</td>
</tr>
</tbody>
</table>

- 3%-4% REOB
- 6%-7% REOB
Hamburg Wheel Tracking
These 2 are the WMA Foamed mixes.

These 3 are the RAS mixes and 40% RAP HMA.
These 2 are the WMA Foamed mixes

These 3 are the RAS mixes and 40% RAP HMA

These are all the others