Moisture Sensitivity Testing

Changes to PENNDOT testing requirements
Stripping
Chemical Stripping Theory

- Water migrates into asphalt and gets into the asphalt / aggregate interface causing a negative charge to develop on both aggregate and asphalt surface over time.

- The asphalt strips from the aggregate because of this repulsive force.
Role of Silicates in Stripping

- Most abundant mineral in the earth’s crust.

- Occur in almost all construction aggregates including most limestone and dolomite.

- Silica in the aggregate reacts with water yielding a negatively charged aggregate surface.
Aggregates Rich in Silica Have More Propensity to Strip

- marble, slag
- limestone
- basalt, diabase
- dolomite
- sandstone
- granite
- quartzite

Stripping Potential

% Silica, by mass
Asphalt roll in stripping

- When water comes in contact with carboxylic acid groups in asphalts a reaction occurs yielding a negative charge.

- Asphalts with high asphaltenes resist this reaction (hydrophobic properties)

- Asphalts with high acidity and low asphaltenes can have poor performance even with low silica percentage aggregates.
  
  - This is why we need to retest mixes when we change asphalt sources.
Indications of a Problem

• Had severe and obvious problems with the premature deterioration of some asphalt mix designs with certain aggregates.

• Districts with moisture damage issues were forced to require minimum amounts of liquid anti-strip additives to mitigate moisture damage problems.

• No mix designs ever seemed to fail PA modified AASHTO T283 testing needing anti-strip.

• Mix designs in border areas with other states needed anti-strip when used in other states but not in PA.
Previous Specification

- The procedure for Moisture Susceptibility testing in PA prior to Oct 20, 2014 had several large differences from the AASHTO T 283 specification.

  - Loose mix is conditioned for 4 hours at 145° C instead of 16 hours at 60° C.
  - Vacuum was applied to conditioned specimens at 254 mm (10 in.) of mercury, for 30 minutes regardless of the degree of saturation.
  - Did not allow any field mixed material to be used for testing. (foamed WMA not testable)
Research Project Started

- COST BENEFIT ANALYSIS OF ANTISTRIP-ADDITIVES IN HOT MIX ASPHALT WITH VARIOUS AGGREGATES research started 2011.

- Final report due May 2015.

- Unexpected results during the material testing phase of the project demanded action.
Test result that told us we had a problem

<table>
<thead>
<tr>
<th>Test Result</th>
<th>Moisture Resistance of Aggregates in Mix</th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Moderate</td>
<td>Poor</td>
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</tr>
<tr>
<td>Passed</td>
<td>3</td>
<td>1</td>
<td>5</td>
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<tr>
<td>Failed</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Error Rates</th>
<th>Type I</th>
<th>Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 %</td>
<td>100 %</td>
<td>100 %</td>
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</tbody>
</table>
# Overall Accuracy of Modified Lottman Procedure, Level 2 Severity as Reported in Literature

<table>
<thead>
<tr>
<th>Test Result</th>
<th>Stripping Potential of Aggregates in Mix</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
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<tr>
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<tr>
<td>Failed</td>
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<td>17.5</td>
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<tr>
<td>Error Rates</td>
<td>Type I</td>
<td>Type II</td>
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</tr>
<tr>
<td></td>
<td>5 %</td>
<td>61 %</td>
<td>25 %</td>
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</tbody>
</table>
Action Taken

• Letter to all producers of bituminous mixtures dated October 20, 2014.
  - Requires all
    **SRL – E and H, 9.5 mm NMAS** mixes must be reevaluated before being used in the 2015 construction season.
  - Any new mix designs submitted must also be evaluated under the new requirements.
  - Districts that currently require minimum anti-strip amounts for certain aggregate types will continue to require them.
Highlights of Revised Testing Requirements

- Allows plant mixed lab compacted mixture to be used for T 283 testing.
  - Gradation and asphalt content for plant mixed material must meet multiple sample ($n \geq 3$) tolerances.
  - Foamed warm mix can be tested.

- Mixture curing times revert to the T 283 curing time of $16 \pm 1$ hour at $60 \pm 3^\circ$C. ($140 \pm 5^\circ$F)
  - Curing times do not apply to field mixed specimens.

- The conditioned specimens must reach a degree of saturation of between 70 and 80 percent.
Highlights of Revised Testing Requirements

- If the DME/DMM determines that moisture susceptibility results are suspect or inconsistent with historical data or field performance, a specified level of anti-strip additive may be required in a mixture at no additional cost to the Department prior to approval.

- All testing is required to be witnessed unless approved by the DME.
• The mixture used to determine the $G_{mm}$ that is required as part of the AASHTO T 283 test must be conditioned identically to the mixture used to produce the samples for the TSR test.

• The bulletin 27 allows the DME to accept the lowest asphalt, highest RAP mixture to represent the JMFs that use the same aggregate combination and PG binder.
  - Only applys to 15% RAP or less.
  - When the conditioned strength is within 5psi of the minimum required AASHTO T 283 TSR strength the nonRAP version should be run also.

• JMFs with different PG grades of asphalt require separate T 283 tests.
2016 & 2017 Requirements

- **All wearing and binder mixes approved in 2016** must be reevaluated using the revised moisture susceptibility criteria in order to be approved in 2016.

- **All Base mixes approved in 2017** must be reevaluated using the revised moisture susceptibility criteria in order to be approved in 2017.
Sources

• C, Ivan Harnish, ArrMaz Custom Chemicals, 2/3/2010 PowerPoint

• Kevin Gnegy P.E., District 9-0

• Don Christensen, Advanced Asphalt Technologies, LLC

• Dennis Morian, Quality Engineering Solutions, Inc.
Questions?