Strengthening Your Quality Assurance (QA) Program for Asphalt Mixture

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NEAUPG
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FHWA is the source for all images unless otherwise noted.
It Is Important – Why?

1. Agency

2. Contractor
Abbreviations & Acronyms

- Abs. = water absorption
- Acc. = acceptance
- G = specific gravity
- G_{mb} = bulk specific gravity of mixture
- G_{mm} = maximum specific gravity of mixture
- G_{sa} = apparent specific gravity of aggregate
- G_{sb} = bulk specific gravity of aggregate
- G_{se} = effective specific gravity of aggregate
- M.D. = mixture design
- NCAT = National Center for Asphalt Technology
- P_{b} = percent binder
- P_{ba} = percent absorbed binder
- P_{be} = percent effective binder
- P_{s} = percent aggregate
- P_{200} = percent aggregate passing the 0.075 mm (No. 200) sieve
- P_{2.36} = percent aggregate passing the 2.36 mm (No. 8) sieve
- QA = quality assurance
- R = correlation coefficient
- RAP = reclaimed asphalt pavement
- RAS = reclaimed asphalt shingles
- V_{a} = percent air voids
- Ver. = verification
- VFA = percent voids filled with asphalt
- VMA = percent voids in the mineral aggregate
Timing for Strengthening Measures

- **Mixture Design (M.D.)**
  - Materials: laboratory mixed

- **Verification (Ver.)**
  - Materials: plant produced
  - Initial check between laboratory and plant produced materials
  - Laboratory mixture design ≠ Plant produced material

- **Acceptance (Acc.)**
  - Materials: plant produced
Strengthening Your QA Program for Asphalt Mixture

1. Ignition Furnace Correction (M.D.)
2. Aggregate Specific Gravity (M.D.)
3. RAP Specific Gravity (M.D.)
4. Mixture Adjustments (Ver.)
5. Aggregate Specific Gravity (Acc.)
6. Relationship of Properties (Acc.)
7. Recycled Materials (Acc.)

Image: Pixabay
1. Ignition Furnace Correction Factor

Asphalt Binder Content ($P_b$):
- Ignition furnace correction factor needed

Correction factor:
- Mixing samples of known asphalt binder content
- Extraction

Agency needs to test
2. Aggregate Specific Gravity: Defined

Specific Gravity ($G$) = \[
\frac{\text{Density of Aggregate}}{\text{Density of Water}}
\]

\[
\text{Density} = \frac{\text{Weight}}{\text{Volume}}
\]

Agency needs to test
2. Aggregate Specific Gravity: Relationship

- \(G_{sa} \geq G_{se} \geq G_{sb}\) (ALWAYS!)
- \(G_{se}\) typically assumed to be halfway between \(G_{sa}\) and \(G_{sb}\)
  
  *Asphalt absorption typically about 50% of water absorption*

- \(G_{sb} > G_{se}\) then negative asphalt absorption (what does that mean?)
2. Aggregate Specific Gravity: Importance

- For test results on a given aggregate:
  - Higher the specific gravity → artificially higher VMA

<table>
<thead>
<tr>
<th>Gsb (in)</th>
<th>VMA (%)</th>
<th>Lower Asphalt Content (%)</th>
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<td>0.010</td>
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<td>0.040</td>
<td>1.2</td>
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</table>
2. Aggregate Specific Gravity: Tolerance

- Should a state use the contractor’s results if within a tolerance?

- **NO!**

*Tolerance of ± 0.02*
2. Aggregate Specific Gravity: Summary

- Use actual values, not a tolerance
- Use agency tests:
  - Specific values measured for each mixture design
  - “Book” values tested annually
  - “Book” values tested based on risk (e.g., 6 months to 5 years)
  - “Book” values tested based on “bench” in the quarry
3. RAP: Gsb

VMA errors result in lower effective binder content
With high RAP, Agency should use G_{sb} of RAP
3. RAP: Gsb

Example if using Gse:
- 20% RAP
- $G_{sb} = 2.609$
- $G_{se} = 2.732$
- Water absorption = 1.0%
- Using $G_{se}$ was similar to using:
  - 0.024 higher $G_{sb}$ in the composite
  - 0.6% VMA (artificially high)
  - 0.3% lower AC

*Use Gsb of RAP*
### Strengthening Your QA Program for Asphalt Mixture

<table>
<thead>
<tr>
<th>Number</th>
<th>Topic</th>
<th>Methodology</th>
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<tr>
<td>1</td>
<td>Ignition Furnace Correction</td>
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<td>6</td>
<td>Relationship of Properties</td>
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<tr>
<td>7</td>
<td>Recycled Materials</td>
<td>(Acc.)</td>
</tr>
</tbody>
</table>
4. Mixture Adjustments: General Rules of Thumb

- **Binder Content Adjustments**
  - ± 0.1% binder content ≈ ± 0.25% air voids (inverse relationship)
  - Small binder content change ≈ no effect on VMA

- **Aggregate Adjustments**
  - ± 1.0% P200 ≈ 0.3% to 1.0% VMA (inverse relationship)
  - Coarse gradation: -P2.36 increases VMA
  - Fine gradation: +P2.36 increases VMA

Keep the binder in the mixture!
### 4. Mixture Adjustments: General Rules of Thumb

#### Changes in VMA

<table>
<thead>
<tr>
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<th>Fine Gradation</th>
<th>Straight Gradation</th>
<th>Coarse Gradation</th>
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<td><strong>P200:</strong> 8% to 3%</td>
<td>+1.6</td>
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<td><strong>P200:</strong> Fine to Coarse</td>
<td>-0.5</td>
<td>+0.1%</td>
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<td><strong>Crushed:</strong> 80% to 100%</td>
<td>+0.3</td>
<td>+1.1%</td>
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Keep the binder in the mixture!
4. Mixture Adjustments: General Rules of Thumb

- Adjust Aggregate Stockpile / Bin Percentages
- Baghouse Fines

Keep the asphalt binder in the mixture!
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3. RAP Specific Gravity (M.D.)
4. Mixture Adjustments (Ver.)
5. Aggregate Specific Gravity (Acc.)
6. Relationship of Properties (Acc.)
7. Recycled Materials (Acc.)

*Image: Pixabay*
5. Aggregate Specific Gravity: Absorption Check

- Absorbed Binder ($P_{ba}$)
  - Percent by weight of aggregate

- $P_{ba} = 100 \times \frac{(G_{se} - G_{sb})}{(G_{sb} \times G_{se})} \times Gb$

- $P_{ba}$ should be consistent

Agency needs to monitor absorption

---

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<th>Test Number</th>
<th>Individual</th>
<th>Avg of Last 4</th>
<th>Gsa</th>
<th>Gsb</th>
<th>Abs, %</th>
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5. Aggregate Specific Gravity: Control Chart

![Aggregate Control Chart](image)

- Aggregate Specific Gravity: $G_{sa}$ determined by T84/T85 prior to production
- Aggregate Specific Gravity: $G_{sb}$ prior to production
- Agency needs to monitor $G_{se}$

$G_{se}$ measured with $G_{mm}$ and $P_b$
5. Aggregate Specific Gravity: Summary

One of Two Options

- Option 1: Monitor Absorption
- Option 2: Monitor Gse
6. Relationship of Properties: Asphalt Content vs. $G_{mm}$

Asphalt Content (%)

Maximum Specific Gravity

- Mix Design
- Field Production
- Average of Field

Agency needs to monitor
6. Relationship of Properties: 
Asphalt Content vs. $G_{mm}$

Project 8

$R = 0.13$

Pay Factor = 1.05
7. Recycled Materials: RAP

- Recordation
  - Minnesota DOT

Agency needs to monitor

- Survey RAP stockpile
  - Utah DOT

- Binder quantity report
  - NCAT recommendation

- Plant inspector: loader bucket counts

Courtesy Minnesota DOT
7. Recycled Materials: RAS

- **Type of Shingles**
  - Manufactured waste
  - Post consumer (tear offs)
- **Quantity of Shingles**
  - Accuracy of metering
  - Checks on metering

**FHWA Tech Brief**
7. Recycled Materials: RAS

RAS Cold Feed System:

- Bar screen over bins
- Steep sided bins
- Reverse weigh system for better feed rate control
- Keep bin levels even through production
- Empty bins at night

*Image NAPA and NCAT*
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Thank you

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