The Cardiac Arrest of Hot Mix Asphalt Pavements

Timothy R. Murphy, P.E.
President
Murphy Pavement Technology

What Are You Really Going To Remember from this Convention?

70% of what you learn today can be forgotten in 24 hours if you do not make a conscious effort to remember it, on average, we remember:
• 20% of what we read,
• 30% of what we hear,
• 40% of what we see,
• 50% of what we say,
• 60% of what we do, and
• 90% of what we see, hear, say and do (Bonnano, 2001)

What will you really remember most about today?

Close-Up of HMA

Longitudinal segregation

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Segregation of Asphalt Mixtures

Segregation is a non-uniform distribution of the various aggregate sizes throughout the mass. Segregation is caused by the methods used to mix, transport, handle, or store the aggregate in the plant under conditions favoring non-random distribution of the aggregate sizes.

Separation of Coarse & Fine Materials

Graded Crushed Stone Bases and Subbases

- Coarse Aggregate
- Fine Aggregate
- Composite Mixture
  - Dense Graded Material
  - Open Graded Drainage
- Construction
**Rock Cap Specification**

- When rock cap is stockpiled prior to hauling to the roadway, testing for final gradation acceptance from the stockpile will be by the State and based only on the percent passing the No. 4. The criteria for the final gradation acceptance of stockpiled rock cap are 0-10 percent passing the No. 4 sieve.
- If a second test also fails to meet specifications, hauling shall be suspended and adjustments made in order to produce acceptable material.

**Cap Rock & Segregation**

- Loss of consistency,
- Loss of strength,
- Loss of life.

### Summary of effects of the minus #200 on a 1-1/2” aggregate base

<table>
<thead>
<tr>
<th>Total Percent Passing No. 200 Sieve</th>
<th>Strength</th>
<th>Frost Heave</th>
<th>VMA</th>
<th>Drainage (k)</th>
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<tbody>
<tr>
<td>0</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
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<tr>
<td>10</td>
<td>60</td>
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<tr>
<td>50</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Frost Heave**

- Ice lenses formed by capillary water from water table
- Frost line
- Water table
On-site Excavation

Trucking to recycling facility

Raw feed

Crushing & screening feed

Finished product
- Rework stockpile to mitigate segregation and improve consistency.
- Pay special attention to head pulley.

What do you see?
Segregation of Asphalt Mixtures

Segregation May Lead To:
- Smoothness Problems
- Density Below Specification
- Loss Of Overall Mat Durability

Segregation of Asphalt Mixtures

Segregation May Lead To: (Cont’d.)
- Moisture Damage & Raveling
- Cracking
- Streaky Pavement Surfaces

Moisture Damage from Segregation

Long Shot

Close-up Shot

Segregation of Asphalt Mixtures

Streaky Pavement Surfaces Resemble:
- Chevrons
- Longitudinal Streaks
- Blotchy Areas
Segregation Leads to Potholes & Premature Failure

There's a gentleman to see you about potholes...

Segregation of Asphalt Mixtures

Segregation May Occur Because Of:
- Mix Designs
- Aggregate Handling
- Asphalt Plant Particulars
- Truck Loading & Unloading
- Paver Operations

Segregation of Asphalt Mixtures

Mixtures, Base & Surface, are Being Designed for High Stress Applications
- Interstate Highways
- Intersections
- Toll Booths
- Bus Stops
Segregation of Asphalt Mixtures

Mix Designs (Gap-Graded)
- Job-Mix Formula Not Well Graded Down Through Fines
- Steep Grading Curve

Gap Graded Mixtures are Difficult to Handle

Evaluation of Asphalt Absorption by Mineral Aggregate
Effective Asphalt Varies with Absorption

Segregation of Asphalt Mixtures

Mix Designs (Cont’d.)
(Large Specific Gravity Differences)
– In-Place Density Requirements
– Heavy Particles Travel Further

Mix Design Summary Slide

High stress applications led to:
– High stability Hveem & 75-blow Marshall designs,
– Reduction to ½ passing #8 sieve,
– Lower AC contents,
– Large differences in aggregate specific gravities,
– Incorrect aggregate specific gravity determination.

Big Rock Requires Attention to Detail

Laboratory Mixture Analysis

Segregation Potential?
– Batch Sample in Laboratory
– Discharge Sample 1 meter
– Analyze Segregated Sample
Laboratory Mixture Analysis

<table>
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<tr>
<th>Sieve Size</th>
<th>Outside</th>
<th>Inside</th>
<th>Factor</th>
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<tr>
<td>12.5mm (1/2&quot;)</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>4.75mm (#4)</td>
<td>45</td>
<td>59</td>
<td>14</td>
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</table>

Marshall Data

| AC  | 5.5 | 5.8  | 0.3   |
| Voids | 5.2 | 3.6  | 1.6   |
| Stability/Flow |    |       | -0    |

Segregation of Asphalt Mixtures

Aggregate Handling
- Producer Stockpiles
- End User Stockpiles
- Loading Cold Bins

Segregation of Asphalt Mixtures

Aggregate Handling
- Dirty Core, Fine Aggregate
- Medium Coarse Aggregate
- Coarse Aggregate
Conveyor
Segregation of Asphalt Mixtures

In General, Segregation Potential Increases the More a Material is Handled.

Different Mass Aggregates have Different Energy

Aggregate Handling

Aggregate Production

Over-Head of Aggregate Handling of Windrow
Cut-Away of Aggregate Handling of Windrow

Segregation of Asphalt Mixtures

Asphalt Plant Particulars (After Cold Bin Feeding)
- Drum Mixers
- Hot Bins on Batch Plants
- Surge & Storage Bins

Head Pulley Discharge

Weigh Bridge Discharge onto Slinger

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Segregation of Asphalt Mixtures

Drum Mixers

Fine

Coarse

Segregation During Drum Discharge

Segregation of Asphalt Mixtures

Drum Mixers

Fixed Plow

Homogenous

Uniformity During Drum Discharge
By Fixing a Plow At Point of Discharge

Drum Discharge

Uniformity During Drum Discharge
By Turning Drag Chain 90°
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**Batch Plant Bin #1**

- Baffle Plate
- Sounders

**Bin Charging Batcher**

- Rotating Chute (straight)

**Silo Storage Levels**

- Maintain HMA level within this range

**Silo Discharge Gate**

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Segregation of Asphalt Mixtures

Truck Loading
– Front, Back & Center Drops
– Baffles at the Dog House

Segregation of Asphalt Mixtures

Truck Unloading
– Tip the Truck Bed Prior to Releasing Tailgate
– Baffles at the Point of Discharge
– Flood the Paver Hopper

Truck Unloading

End of load segregation with belly-dump.
**Segregation of Asphalt Mixtures**

**Paver Operation**
- Keep The Paver Moving
- Maintain 25% Capacity in Hopper
- Dump Wings Only When Material is in Hopper

**GOOD!!!**

**BAD!!!**

**Segregation of Asphalt Mixtures**

**Paver Operation (Cont’d.)**
- Fillets in Corners
- Kick-Back Plates
- Head in Augers
- Auger Extensions

**Paver Operation, Hopper**

**Paver Operation, Hoppers**

**Paver Operation, Hoppers**
Uniform HMA
Segregation from pick-up machine. Fold hopper wings.

Paver Operation
BAD!!

Truck tailgate baffles

Longitudinal Cracking

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Superpave Specification Requirement
Reverse screw augers with a minimum efficiency of 75% shall be installed at the gear box for all paving activities.

Longitudinal Cracking

Longitudinal Cracking Mitigation
Extended screeds must be installed...
Extended screeds shall be provided with corresponding auger and tunnel extensions to ensure a uniform head of fresh material across the entire screed.
Streaking

Strike-off

Correct Wear

Too High Rocks are Dragged Fines Accumulate

Strike-off

Too Low Wear

Wear

Rocks are Dragged

Fines Accumulate

Streaking

Luting

Longitudinal Joint Luting

Night Time Paving

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Can You Find the Segregation?

Segregation Before Mixing

Segregation After Mixing

Model Segregation Specification

- Conduct evaluations of existing projects
- Develop evaluation strategy
- Verify test method being used
- Develop end-product specification

Model Segregation Specification

Segregation specification minimums:
- Description
- Definitions of types and severity
- QC responsibilities of the contractor
Segregation specification minimums: (cont’d.)
- Investigations
- Dispute resolutions
- Acceptable corrective actions
- Basis of payment

<table>
<thead>
<tr>
<th>Type</th>
<th>Slight</th>
<th>Medium</th>
<th>Severe</th>
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<tbody>
<tr>
<td>Condition</td>
<td>Mastic ok, slight coarseness</td>
<td>Mastic missing, very coarse</td>
<td>Mastic gone, stone on stone</td>
</tr>
<tr>
<td>Action</td>
<td>Typically acceptable</td>
<td>Seal or pay adjustments</td>
<td>Remove and replace</td>
</tr>
</tbody>
</table>

Agencies now use one of the following for quantifying segregation:
- Deviation from the approved JMF via extraction
- Sand patch measurement
- Nuclear density gauge

Homogeneous Asphalt Mixtures Ensure Us Of Having Smoother and More Durable Asphalt Pavements

Segregation Elimination

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Segregation Elimination

Idaho Transportation Department
Superpave Level II Qualification Training

This is the Qualification Training Course Needed to Perform State of Idaho Superpave Asphalt Mix Designs

Lecture Issues (Timothy R. Murphy, P.E., Murphy Pavement Technology)
- IID Superpave Specification Covered in Detail
- Analyze Voids, VMA, and VFA - The Building Blocks of Hot Mix Asphalt
- Learn How to Build Acceptance Test Stips to Achieve Maximum Quality & PWL
- Compare Superpave vs. HMA Mix Designs
- Discover & Explore Troubleshooting Techniques

Laboratory activities (ITD Personnel)
- Splitting Asphalt & Aggregate Property to Test Size
- Aggregate Specific Gravity
- Fine & Coarse Aggregate Angularity
- Hot & Thorough
- Blending & Batchmix Aggregates
- Mixing & Testing asphalt
- Ignition Oven Calibration
- Segregation Corrector Calibration

Monday, January 8, 2007 - Friday, January 12, 2007
[Note: Pre-requisite test included]
IID Central Materials Lab
3235 Jordan St.
Boise, ID 83721

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Caldwell, ID 83605

Questions?

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