Mix Optimization for Quality and Consistency

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Some Definitions…

- **Optimize**: To make something as good or as effective as possible

- **Quality**: A high level of value or excellence

- **Consistent**: Always acting or behaving in the same way

*Merriam-Webster.Com*
What’s Your Definition of an Optimized Mix?

- Contract Requirements
- Economical
- Reproducible
- Compactable and Non-Segregating
- Workable and Controllable
- Achieve Full Pay
Meets or Exceeds All Contract Requirements

- Gradation
- VMA and Voids
- Binder Replacement
- Stripping Test
- Density
- Non-segregating
- Smooth
- Hamburg Wheel
- Future Cracking Test…?
Economical  ≠  Cheapest

The most economical blend seeks the right balance between material costs and design characteristics that influence pay and customer satisfaction.

• As-Produced vs. Design material costs (produce a quality mix at or below design material cost)

• Bonus vs. Penalty dollars achieved (achieve maximum pay for each mix on each job)

• User-Friendly to all parties involved (plant, lab, laydown)
Reproducible

- Achieve **accurate** mix design results
  - Aggregate specific gravities
  - Consistent and Correct
    - Blending, mixing, handling, specimen preparation and specimen testing
  - Do the results make sense?
  - Verify blend gradation and AC content achieved

- Account for anticipated VMA loss
  - Know what was achieved in the design
  - Field data evaluation
Compactable, Non-Segregating

The *Bailey Method* relates to:

- Field Compactability, Segregation Susceptibility and Tenderness
  - CA volume relative to mix type and **lift thickness**
  - CA ratio
  - $F_{Ac}$ and $F_{Af}$ ratios

- Do you have a systematical approach to mix evaluation (design and field)?
Laboratory Mixture Analysis
Segregated Mix

4.75mm and AC Content per Sample
Segregated Mix

2.36mm and AC Content per Sample

[Graph showing data points for 2.36mm Sieve and AC Content across different samples, with a circled section highlighting variability in the data.]
Non-Segregated Mix

2.36mm and AC Content per Sample
Workable and Controllable

- Volumetric **adjustability** during production
  - Key to meeting volumetrics, while maintaining cost effectiveness
  - Achieving a blend and corresponding volumetrics that provides a **workable** mix
- Sensitivity to field gradation **changes** as it relates to mix **control**
  - What method do you have for analyzing mix results to provide an indication of sensitivity to change relative to volumetrics, density, and performance tests?
Other Issues to Consider…

- Design should take into account job specific characteristics, such as:
  - Silo time
  - Haul time
  - **Lift thickness**
  - Handwork
  - Underlying base
- **Communication** is vital!
In The Past...

Quality Control

Plant

QC Manager

Road
Moving Forward As A TEAM!

Quality Control
Plant
Laydown

Everyone Plays a Role in QC!

Train them, Enable them, Support them, and Hold them Accountable
Things That Handcuff Us…

• Low Bid System
  – We have to compete!
  – Not enough pie!

• Challenging Decisions…
  – Multiple mixes
  – Production/Placement rate
  – Stockpile area
  – Commitment

• Locally Available Materials

• Lift Thickness
## HMA Lift Thickness vs. NMAS and Mix Type

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size</th>
<th>NCAT Coarse-Graded 4 x NMAS</th>
<th>NCAT Fine-Graded 3 x NMAS</th>
<th>IDOT Specification 3 x NMAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5mm (3/8”)</td>
<td>1-1/2”</td>
<td>1-1/8”</td>
<td>1-1/4”</td>
</tr>
<tr>
<td>12.5mm (1/2”)</td>
<td>2”</td>
<td>1-1/2”</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>19.0mm (3/4”)</td>
<td>3”</td>
<td>2-1/4”</td>
<td>2-1/4”</td>
</tr>
<tr>
<td>25.0mm (1”)</td>
<td>4”</td>
<td>3”</td>
<td>3”</td>
</tr>
</tbody>
</table>

Info from Fine-Graded Literature Review Performed by Murphy Pavement Technology
Mix Optimization

Where do you start?....

• Trial and Error?
  – Experience
  – Specification Bands

• Which blend is best?

• How will it work at the plant and in the field?

• How will it perform?

• Today, it requires a more systematical approach to design and control a mix to achieve success!
Thank You