Overview

• Why am I here?
  - ‘New’ system in Montana, low bid, but quality is most important under construction.
  - Volumetrics only mix quality requirement under construction.
  - Hamburg, Density and Ride.
  - First projects let in 2003, never looked back

A little History, how we got here-

• Volumetric properties weren’t really new.
• Marshall trailers, all jobs beginning 1984.
  - Volumetrics and gradations
  - Idea was developed into a NHI course later
  - Mix adjustments, continuous, begun.
  - Density, in place voids – Cores, Nuclear
  - AC content-Extractions, Nuc AC, Ign. Ovens

....History, How we got here....

• Statistical payment – Gradations
  - Lot systems
  - Random Sampling
  - Incentives & Disincentives
Asphalt Binder Research

- 1990s Dr Wynn Jennings, MSU, Molecular Size, blending of Montana Asphalts
- Dr Joe Armijo & Murari Pradham, Montana Asphalt Binders and New Polymer Modifiers
  - Test projects
  - Led to widespread Polymer Modified asphalt use
  - All polymers OK
- PG binders, early adoption

Mix Research and History

- Marshall mixes, rutting issues Eastern Montana
  - Largely sand mix ‘B’
  - “Anti-rutting”
  - ‘D’ mix, high VMA, high asphalt content, high aggregate quality, no naturals, Meets Superpave
  - Good mix but we can do better
  - Hamburg research - wanting performance prediction

So what did we do?

- Along came Superpave
- Liked what we saw but some issues
  - Lower asphalt content by about 1%
  - Lower aggregate quality requirements
  - No strength measure
- Adopted Carefully
  - There was essentially no guidance on specifications
  - Involved converting to a **GRADATION** specification.

Superpave

- Liked it, after a bit of tweaking, really not *that* much different.
- Contractors were meeting the Gradation specs, (pay factors!),
  - Volumetric Req’s?
- More good training!
- Good equipment!
- Superpave without the Twist
How to achieve Volumetrics??

• All we really want is:
  – Gradation, Asphalt Content, Voids, VMA, VFA, Dust Asphalt ratio
  – All in spec, then we have PERFORMANCE?
  – No “Wiggle Room”

• Hadn’t controlled for volumetrics,
  – Had no idea of capabilities

MDT’s Performance Specification

• All Superpave Volumetric properties, at 2% incentive each
  – Use all four volumetric properties
• If 3 properties in incentive, 4% bonus
  – 12% max
• Hamburg, Design and Production requirements

• That’s IT! Simple .. .. .. !

• Focus on helping Contractor to make the best possible mix!
  – Owner will get best possible value!

Volumetric Requirements.
Targets and Ranges

• Voids in Mineral Aggregate (VMA) 13 to 17 +/- 0.6
• Voids Filled with Asphalt (VFA) 65 to 80 +/- 5.0
• Voids in Total Mix (VTM) 3.4 to 4.0 +/- 1.0
• Dust Asphalt Ratio (D/A), Meet Dust Effective Asphalt Ratio at mix design.
  – No target limits in production, +/- 0.2
Other Necessities:

- Field test trailers,
  - Gyros and Ignition ovens
  - Testing, full time, on the job, until completion
- Startup very important, lots of testing and adjustment as needed, by Contractor
- Some ‘Free mix’ no QA until second lot, target set
- Contractor may change targets at the end!
  - Similar to PWL system, no chasing bad target
  - Encouraged to set targets early to maximize mix in QA

Density, good field control
- We use 93% minimum
- 94 to 95% incentive range
- 5% incentive available.
- Ride, brings it all together.
  - Up to 25% incentive possible depending on class of road and work.
- Good Communication - Sales

More Necessities

- Good computer program to track it all
- Contractor controls Asphalt Content, and
  - Asphalt separate pay item
  - Asphalt content big factor in volumetric properties, density, ride, durability, permeability, (and permanent deformation).
- Money for the more expensive testing equipment . . . !
Hamburg Requirements

- Low requirements, separator of ‘good’ from ‘bad’ mix.
- Applies to the Mix Design - Hurdle
- Applies during Plant Mix Production and must be met to qualify for QA incentive and prevent shut-down order.
- Must be Sampled before second Lot of Production for confirmation test.
- Additional testing at any time as needed.

Quality Incentive Potential

- 12 Percent for Volumetrics
- 5 Percent for Density
- 10 to 25 Percent for Ride

42 Percent incentive is achievable

How is it Working?

MDT perspective –
- Quality has improved quite remarkably
- Better relations on the projects
- Incentives being bid back in
- We cannot mess anything up and meet volumetrics!
- Paying attention to the details, slower steadier production
- Very pleased from project crews on up to the Construction Engineer

Contractor perspective
- Found the “volumetric dial”
- Got the State out of our control shacks
- Most had some difficulties with their first projects
- Crushing, including QC has become major concentration
- Learned what it takes to be consistent
Montana’s Volumetric Specification

It is more than just Volumetrics
It is:
- Following Superpave Methodologies
- An end result specification
- Follows statistical acceptance methods

Hamburg Wheel Tracker Progress
1992 Results

2003 Typical Results

Typical Hamburg Results Today
WITH VOLUMETRIC ACCEPTANCE
### Performance Comparisons: Montana Vs. Adjacent States

<table>
<thead>
<tr>
<th>Distress, Average</th>
<th>Montana Sections</th>
<th>Adjacent State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutting, in.</td>
<td>0.29</td>
<td>0.50</td>
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<tr>
<td>Transverse Cracking, ft./mi.</td>
<td>479</td>
<td>2026</td>
</tr>
<tr>
<td>Semi-Rigid; Fatigue Cracking</td>
<td>None</td>
<td>55%</td>
</tr>
<tr>
<td>Longitudinal Cracking, ft./mi.</td>
<td>965</td>
<td>1576</td>
</tr>
<tr>
<td>Raveling</td>
<td>None</td>
<td>30%</td>
</tr>
</tbody>
</table>

Result: Systematic difference in performance between Montana sections & those in adjacent States

### Topics to be Quantified (not included within scope of work)

1. Benefit & effect of pavement preservation activities on reducing distress & extending a roadway's serviceable life.
2. Benefit of increased density: comparison of roadways with lower and higher air voids.
3. Determine reason for differences between LTPP & MDT FWDs.
4. Continue to measure IDT strength, modulus, strain at failure, & creep compliance on some mixes for use with the MEPDG.
5. Wear from use of studded tires believed to be minor on non-LTPP & other segments of roadways included within study.

### Questions?

*If Contractors and MDT Project Managers are happy, Everybody is Happy!*

### Montana’s Volumetric Specification

Presentation Overview
- How we got where we are today.
  (Specification Development)
- Unusual portions of the specification
- Review of the specification
- Contractors perspective
- Owner/agency perspective
Volumetric Specification Development

- Benefits of modifying the existing specification
  - Transition from “method” to “end result” specification
  - Easier to evaluate with newer equipment
  - Better represents the actual mix
  - Simplified contract administration