Selecting the Right Mix

Outline

- History
- Performance Graded Binders
- NAPA Guide
- MDOT Guide
- Local Agency Guide
- Mixes Generally Used
- Other Considerations
Selecting the Right Mix

The Right Mix at The Right Place
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From Bike path...
...to Local Road

...to Interstate
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For each there are:

- Right mixes
- Wrong mixes
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Mix History
Asphalt Mix History

1970’s

- 4.11 Bituminous Aggregate Pavement
- 4.12 9A Binder
- 25A Leveling/Wearing
- 31A Wearing
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Stability Mixes

1980’s

- #500 & #700 20C Bases
- #1100 L & T 20A, 20AA
- #1300, #1500, #1800 L &T 20AA
Performance Mixes

1990’s

- 2B, 2C Bases
- 3B, 3C Leveling
- 4B, 4C Top
- 11A Base, Leveling,
- 13, 13A Base, Leveling, Top
- 36A, 36B Leveling, Top
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SuperPave Mixes

2000’s

- E03, E1, E3, E10, E30, E50
- 2EO3 thru 5E50
Asphalt Cement History

- Penetration Grades – 1920’s
  - 85-100
  - 120-150
  - 200-300
- Viscosity Grades – 1960’s
  - AC-2.5
  - AC-5
  - AC-10
- PG Binders: Mid 90’s
  - PG 58-28
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Performance Graded Binders
SUPERPAVE
Performance Grade (PG)
Binder Specification

- Fundamental properties related to pavement performance
- Environmental factors
- In-service & construction temperatures
- Short and long term aging
PG Specifications

- Based on rheological testing
  - Rheology: study of flow and deformation
- Asphalt cement is a viscoelastic material
- Behavior depends on:
  - Temperature
  - Time of loading
  - Aging (properties change with time)
Superpave Asphalt Binder Specification

The grading system is based on climate

PG 64 - 22

Performance Grade

Min pavement temperature

Average 7-day max pavement temperature
Developed from Air Temperatures

- Superpave Weather Database
  - 6500 stations in U.S.
    and http://www.ltppbind.com/ Canada
- Annual air temperatures
  - hottest seven-day temp (avg and std dev)
  - coldest temp (avg and std dev)
- Calculated pavement temps used in PG selection

> 20 years
Convert to Pavement Temperature

- Calculated by Superpave software
- High Temperature (20 mm below surface of mixture)
- Low Temperature (at surface of mix)
Superpave Asphalt Binder Specification

The grading system is based on climate

**PG 64 - 22**

- Performance Grade
- Min pavement temperature
- Average 7-day max pavement temperature
Binder Grade Selection

Grade varies with:

- Location/Environment
- Reliability
- Traffic level
- Traffic speed
- Depth in Pavement Structure
Binder Grade Selection

Resources:

- Published Guides
  - MDOT HMA Mixture Selection Guidelines
  - Local Agency HMA Selection Guidelines

- LTTPBind Software
  - http://www.ltppbind.com
What Binders are Used in Michigan

- 76-28P
- 70-22P, 70-28P
- 64-28, 64-34P
- 64-22
- 58-28
- 58-22, 58-34
Is a PG a Modified Binder?

- Effect of Loading Rate
- Reliability
- Rounding
- Effect of Traffic

“Rule of 90”

Example: PG 64-34 has a temperature range of 64 to -34 or 98°C. Therefore, this binder is probably modified!! *(Depends on Asphalt Source!)*
Other Performance Factors:
• Rutting - shear strength of mix, aggregate properties
• Fatigue Cracking - pavement structure, traffic

Important Factor:
• Low temperature Cracking – correlates well to binder properties
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NAPA Guide
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What’s in the Guide

- Pavement layers and traffic level definitions
- General surface preparation recommendations
- Mix Types
  - Definitions
  - Purpose
  - Materials
- Procedure for selecting mixes
- Examples
Selecting the Right Mix

The following guidelines have been developed in the context of Local Agency Engineer’s Incentive Local Agency projects. These guidelines have been followed and approved by the Highway Road Association of Michigan Engineering Committee. Fantastic implications are performed shall prove violations from these guidelines.

These guidelines provide for the selection of Hot Mix Asphalt (HMA) mix design criteria utilizing the Superpave mix design system along with the Michigan C design system. The above table provides Superpave specifications for projects up to Commercial ADT to 2000.

The submittal of industry mixtures data other than specified in the specifications is determined to perform under similar initial conditions.

A. HMA Mixture Type and Binder selection

Selection is based on present-year commercial ADT. The commercial ADT ranges for each of the mixture types have taken into account an assumed future traffic growth rate.

<table>
<thead>
<tr>
<th>Mixture Type</th>
<th>Top</th>
<th>500 or 369A</th>
<th>500 or 369A</th>
<th>700-1000</th>
<th>2001-3000</th>
<th>4001-5999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superpave</td>
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</tr>
<tr>
<td>Base</td>
<td></td>
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<tr>
<td>Binder Grades by Region</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Superior</td>
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<td></td>
</tr>
<tr>
<td>Base</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All Others</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The recommended binder grades for mixtures used to determine PC60-22 for all regions except the Superior Region are PG 64-22. The base course is followed as all layers above 4 inches of the surface. For mixture layers which fall within the 4-inch threshold, the following rules apply. If less than 35% of a mixture layer is within 4 inches of the surface, the mixture layer should be considered for a base course.
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Local Agency Programs
HMA Selection Guidelines

- Developed for use on Local Agency Projects
- Reviewed and Approved by CRAM
- Variations Allowed
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Local Agency Programs
HMA Selection Guidelines

- SuperPave and Marshall mix designs
- SuperPave for Commercial ADT > 700
- Variations Allowed
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Local Agency Programs
HMA Selection Guidelines

- Selection based on Present Day two-way commercial ADT
- Assumed future growth
## Local Agency Programs

### HMA Selection Guidelines

<table>
<thead>
<tr>
<th>Commercial ADT</th>
<th>0 – 300</th>
<th>301 – 700</th>
<th>701 – 1000</th>
<th>1001 – 3400</th>
<th>3401 – 9999</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mixture Type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td>13A or 36A or LVSP</td>
<td>4C 5E1</td>
<td>5E3 or 4E3</td>
<td>5E10 or 4E10</td>
<td>5E30 or 5E10</td>
</tr>
<tr>
<td>Leveling</td>
<td>13A or LVSP</td>
<td>3C 4E1</td>
<td>4E3</td>
<td>4E10</td>
<td>4E30</td>
</tr>
<tr>
<td>Base</td>
<td>13A</td>
<td>2C</td>
<td>3E3</td>
<td>3E10</td>
<td>3E30</td>
</tr>
</tbody>
</table>
## Local Agency Programs

### HMA Selection Guidelines

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<tbody>
<tr>
<td><strong>Binder Grades by Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior</td>
<td>PG 58-34</td>
<td>PG 58-34</td>
<td>PG 58-34</td>
<td>PG 58-34</td>
<td></td>
</tr>
<tr>
<td>Metro</td>
<td>PG 58-22</td>
<td>PG 64-22</td>
<td>PG 64-22</td>
<td>PG 64-22</td>
<td>PG 70-22P</td>
</tr>
<tr>
<td>All Other</td>
<td>PG 58-28</td>
<td>PG 64-28</td>
<td>PG 64-28</td>
<td>PG 64-28</td>
<td>PG 70-28P</td>
</tr>
</tbody>
</table>
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Local Agency Programs
HMA Selection Guidelines

- **Base Course Binder Selection**
  - Use PG 58-28 for Superior Region
  - Use PG 58-22 for all other Regions

- **A Base Course is defined as:**
  - All layers below 4” of the surface
Local Agency Programs
HMA Selection Guidelines

- **Target Air Voids**
  - Mixes are specified with 4% design AV
  - Can be reduced to 3% for 13A and 36A mixes
    - Add a note to the HMA Application Table
  - Reduce shoulder mixes to 2.5% AV
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Local Agency Programs
HMA Selection Guidelines

- One Course Overlays
  - Decrease cold temperature number of the PG Binder by one grade
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Local Agency Programs
HMA Selection Guidelines

<table>
<thead>
<tr>
<th>Mixture Type</th>
<th>Marshall Mixture</th>
<th>Superpave Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>36A</td>
<td>13A</td>
</tr>
<tr>
<td>Min. #/syd</td>
<td>110</td>
<td>165</td>
</tr>
<tr>
<td>Max. #/syd</td>
<td>165</td>
<td>275</td>
</tr>
</tbody>
</table>

Note: Application Rate of 110#/syd. Per 1 inch Thickness
Local Agency Programs
HMA Selection Guidelines

- Aggregate Wear Index
  - Specified for Surface course mixes
  - Based on ADT (vehicular and commercial) per lane

<table>
<thead>
<tr>
<th>ADT/Lane</th>
<th>Minimum AWI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100</td>
<td>None</td>
</tr>
<tr>
<td>100 – 2000</td>
<td>220</td>
</tr>
<tr>
<td>&gt; 2000</td>
<td>260</td>
</tr>
</tbody>
</table>
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Other Considerations
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Recycled Asphalt Pavement (RAP)

- Proven Technology
- Proven Performance
- Economical
- Readily Available
Selecting the Right Mix

Binder Considerations

- Reduce added binder to account for RAP binder
- For higher RAP contents, use softer virgin binder grade
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MDOT Practice for Using RAP

- RAP percentage based on % of RAP binder to total binder in the mix
- Depends on specific rap and % AC in mix
- Generally allows more RAP before adjusting Binder grades
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DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
FOR
RECYCLED HOT MIX ASPHALT MIXTURE

Add the following subsection to Section 601.62.2 of the standard specifications:

a. Recycled Asphalt Pavement (RAP) Percentages and Binder Grade Selection. The RAP content for determining the design grade of the asphalt mixture is determined as follows:

The RAP is divided into four categories designated Tier 1, Tier 2, Tier 3, and Tier 4. Each tier has a range of percentages that represent the proportion of the RAP binder to the total binder by weight. The tier definitions below apply to both Superpave and Marshall mixes, with the following exceptions:

- Superpave mixtures types E3, E5 high stress, and E10 used as bonding or top course shall be limited to a maximum of 12% RAP binder by weight of the total binder in the mixture.
- Superpave Mixture types E10 High Stress, and all E30 and E50 mixtures used as leveling or top course shall be limited to a maximum of 20% RAP binder by weight of the total binder in the mixture.

Tier 1 (0% to 17% RAP binder by weight of the total binder in the mixture)

No binder grade adjustment is made to compensate for the stiffness of the asphalt binder in the RAP.

Tier 2 (18% to 27% RAP binder by weight of the total binder in the mixture)

The selected binder grade for the asphalt binder is also the grade for the high temperature binder that the RAP binder required for the specified project mixture type. For example, if the specified binder grade for the mixture type is PG64-22, the required grade for the binder in the RAP-based mixture would be a PG64-22.

The asphalt binder grade can also be selected using a blending chart for high and low temperature. The Corrosion Resistance by the blending chart and the RAP binder data used in determining the binder selection.

Tier 3 (28% to 99% RAP binder by weight of the total binder in the mixture)

The binder grade for the asphalt binder is selected using a blending chart for high and low temperature. The Corrosion Resistance by the blending chart and the RAP binder data used in determining the binder selection.
Selecting the Right Mix

MDOT Practice for Using RAP

- 0 to 17% RAP, no change in binder grade
  - (approx. 22 to 23% RAP by total wt.)
- 18-27% RAP,
  - (approx. 23 to 29% RAP by total wt)
  - lower binder grade by one increment
  - PG 58-28 → PG 52-34, or 58-34
- More than 28%, use blending charts
  - > 30% RAP by total wt
Binder Selection

Economics:
- Existing Pavement Condition
- Fix Life
- Low Temperature Cracking “Protection”
Binder Selection

Example:

- 1 ½” resurfacing of existing road
  - 98% reliability binder grade is PG 58-34
- Consider using PG 58-28?
  - Reflective cracking
Lift Thickness vs. Performance

- **In-place Density is Critical**
  - Initial In-place Air Voids <8%

- **Lift Thickness Affects Compaction**
  - Consolidation “Room”
  - Cooling Rate
NCAT Recommendation for SuperPave Mixes

Minimum Layer Thickness

- Fine Graded = 3 x Nominal Maximum Aggregate Size (NMAS)
- Coarse Graded = 4 x NMAS
Selecting the Right Mix

Mixture Selection Procedure

- Determine Total Asphalt Thickness
- Select Surface Course Type
  - NMAS
  - Minimum Lift Thickness
  - Repeat Process for remaining HMA layers
Binder Grade vs. Pavement Performance

Important Factor:
- Low temperature Cracking – correlates well to binder properties

Other Factors:
- Rutting - shear strength of mix, aggregate properties
- Fatigue Cracking - pavement structure, traffic
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Questions?

www.apa-mi.org
517.323.7800    800.292.5959