Agenda

- Specification History
- Design Considerations
- New Technology
Plant Mixed Asphalt

- **Components**
  - Asphalt Binder
  - Aggregate

- **Mixture Provides**
  - Stability
  - Durability
  - Impermeability
Mixture Objectives

- Resistance to Rutting
- Resistance to Thermal Cracking
- Resistance to Fatigue Cracking
Minimizing Distress

- **Rutting**
  - Aggregate with high degree internal friction
  - Stiffer asphalt, lower asphalt content

- **Thermal Cracking**
  - Control air voids
  - Softer asphalt binder

- **Fatigue Cracking**
  - Thicker pavement structure, control air voids
  - Asphalt binder not too stiff, not too soft
Bituminous Specification Timeline

- Specification 2331 (Pre 1988)
- Specification 2340 (1988)
- Specification 2340 Modified (1997)
- Specification 2350/2360 (1998)
- Specification 2360 (2010)
Specification 2331

- Agency Designed Mixes for Contractor.
- Process Control and Acceptance by Agency:
  - Asphalt Spotchecks
  - Aggregate Gradation
- 2 Pay Items: Bituminous Material, Mixture
- Contractor Role To Produce and Place Mix
Specification 2340

- Implemented in 1988
- Address problems associated with rutting and flushing.
- Single Pay Item for AC & Mixture
- Contractor Involvement
  - Mix Design
  - Process Control Testing
  - Agency Acceptance (Assurance) Testing
2340 Acceptance (Assurance) Criteria

- Bituminous Mixture
  - Air Voids
  - Asphalt Content
  - Aggregate Gradation

- Pavement
  - Density
Specification 2340 Modified

- Implemented 1997
- Enhancement to 2340
- New Mixture Quality Measures
  - Voids in Mineral Aggregate (VMA)
  - Moisture Susceptibility (TSR)
- Increased Testing and Frequency
Specification 2350/2360

- Implemented in 1998
- Replaced 2331 and 2340
- 2350 (Marshall design) -- Required on all MnDOT projects with traffic < 3 million ESAL’s.
- 2360 (Superpave Gyratory design) -- Required on all MnDOT projects with traffic > 3 million ESAL’s
- Move toward end result
Specification 2360

- Current Plant Mixed Asphalt Provision
- Superpave Gyratory Design
- Used on all Traffic Levels
Design/Production Changes Over the Years

- Change from 2 bid items to 1 bid item.
- **Contractor Mix Design.**
- **Process control testing.**
  - 2331: Spotcheck, gradation (Agency testing)
  - 2340: Spotcheck, gradation, air voids (Agency/Industry)
  - 2350/60: Spotcheck, grad., AV, VMA, crushing (Agency/Industry)
  - 2360: Spotcheck, grad., AV, AFT, crushing (Agency/Industry)
Density Changes over the Years

2331/2340
- 2331: Ordinary, Control Strip, Specified Density
- 2340: Ordinary, Modified Specified Density

2350/2360
- 2350/2360: Ordinary, Maximum Density
Compaction Methods

- **Maximum Density Method**
  - Inspector determines and marks coring locations on a random basis.
  - Cores cut to determine density.
- **Ordinary Compaction**
  - No cores are cut.
  - Typically develop a control strip (growth curve) to establish rolling pattern.
2360 Design Considerations

- Aggregate Size
- Mixture Selection
- Density
Aggregate Gradation Broad Bands (percent passing of total washed gradation)

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in [25.0 mm]</td>
<td>—</td>
<td>—</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>¾ in [19.0 mm]</td>
<td>—</td>
<td>100*</td>
<td>85 – 100</td>
<td>—</td>
</tr>
<tr>
<td>½ in [12.5 mm]</td>
<td>100*</td>
<td>85 – 100</td>
<td>45 – 90</td>
<td>—</td>
</tr>
<tr>
<td>⅜ in [9.5 mm]</td>
<td>85 – 100</td>
<td>35 – 90</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 [4.75 mm]</td>
<td>60 – 90</td>
<td>30 – 80</td>
<td>30 – 75</td>
<td>65 – 95</td>
</tr>
<tr>
<td>No. 200 [0.075 mm]</td>
<td>2.0 – 7.0</td>
<td>2.0 – 7.0</td>
<td>2.0 – 7.0</td>
<td>3.0 – 8.0</td>
</tr>
</tbody>
</table>

* The Contractor may reduce the gradation broadband for the maximum aggregate size to 97 percent passing for mixtures containing RAP, if the oversize material originates from the RAP source. Ensure the virgin material meets the requirement of 100 percent passing the maximum aggregate sieve size.
Aggregate Considerations

- **1/2” vs. 3/4” vs. 1”**
  - Minimum Lift Thickness: 2X Max. Aggregate Size.
  - Use 1” in non-wear only
- Typically, aggregate selection is based on personal preference.
Wearing Course Aggregate Size

- Consider “A” (-1/2”) gradation for final lift
  - Similar to MV 4 mixes
  - Finer mixes are a little easier to compact
  - Less prone to segregation
  - Will make a better joint than coarser mixes

- “A” can be used on all traffic levels.
Mixture Selection

- Traffic Levels
  - AADT, ESAL’s
- Traffic Type
  - Fast, Slow
- Asphalt Binder
  - New construction or Overlay?
Traffic Levels

- Traffic Levels 2-5
  - As Traffic Levels Increase:
    » Gyrations Increase
    » Crushing, both coarse and fine, increases
    » Aggregate quality levels are more restrictive.

- Select the Appropriate Traffic Level Mixture Based on AADT or ESAL’s
  - Bumping up of TL may be necessary for slow traffic.
Aggregates in Hot Mix

- Key to Non-Rutting Pavements
  - Crushed Aggregate in both coarse and fine
  - Adequate Void Properties
Construction Type/Selection of Asphalt Binder

- **New (re-construct)**
  - With new or reconstruct, typically, select a grade that will minimize potential for thermal cracking.
    - PG 58-34 or PG 64-34

- **Overlay (mill & overlay)**
  - With overlay or mill and overlay construction it is not necessary to control thermal cracking…reflective cracking happens.
    - PG 58-28 or PG 64-28
Adjustments for Traffic Type/Selection of Binder & Traffic Level

- Fast Traffic -- Average speeds of greater than 45 mph, rural highways with sustained speeds.
  - No adjustments necessary
- Slow -- Average speeds slower than 45 mph, urban stop & go conditions.
  - Can either specify next higher Traffic Level (ex. 3 instead of 2) or specify higher asphalt binder grade (ex. PG 64-28 instead of PG 58-28).
# Mixture Designation Replacement Chart

(Example mixes shown)

<table>
<thead>
<tr>
<th>Marshall</th>
<th>Gyratory (Superpave)</th>
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<tr>
<td>Wear (Top 3” of structure)</td>
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<td>LVWE35030X (-3/4”, 3.0% Voids)</td>
<td>SPWEB240X (-3/4”, 4.0% Voids)</td>
</tr>
<tr>
<td>Alternate: SPWEB230X (-3/4”, 3.0% Voids)</td>
<td></td>
</tr>
<tr>
<td>LVWE45030X (-1/2”, 3.0% Voids)</td>
<td>SPWEA240X (-1/2”, 4.0% Voids)</td>
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SP Level 2: AADT < 2300
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<td></td>
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**SP 3: 2300 < AADT < 6000**
Example Typical Section for Mainline Pavement New Construction

[Note: Thicknesses Dependent on Foundation]

6.0” AGGREGATE BASE
CLASS 5

3.0” (PLACED IN TWO EQUAL LIFTS)
TYPE SP 12.5
WEARING COURSE MIXTURE
( SPWEA240C ) PG XX-34

5.0” (IN TWO LIFTS)
TYPE SP 12.5
NON WEAR COURSE MIXTURE
( SPNWB230B ) PG 58-28
RAP

- Allowed permissively by specification:
  - Meet add/total AC ratio of 80% with PG XX-34
  - Meet add/total AC ratio of 70% with PG XX-28
- RAP has economical & environmental value.
- MnDOT has seen RAP mixture performance equivalent to virgin mixture performance.
It’s not just the Mixture….

- Select an aggregate and asphalt binder combination adequate for meeting given traffic levels and conditions.
  - 3% voids, “A” aggregate size, adequate structure.
- Keep number of mixes specified on a project to a minimum.
- But remember…mixture alone won’t guarantee performance on the roadway.
  - We also need to pay attention to:
    » Proper placement, including uniform tack coat application and no segregation of mixture as it is being placed.
    » Ensuring we get adequate density or compaction on the roadway and at the joints.
    » Using the best construction techniques.
    » Following the correct procedures and paying attention to details.
New Technology

- Paver Mounted Temperature Bar
- Intelligent Compaction
12 sensors spaced 1 foot apart, reading interval = every 6 inches

Special Provision 2016
Quality Management – Paver Mounted Infrared Temperature Bar
Paver Mounted Infrared Temperature Bar

- Measure temperature differentials (150 foot segments)
- Paver Speed
- Paver Stops and duration
- GPS coordinates
Intelligent Compaction
Final Payoff

Better asphalt pavements.
Extended service life.
Improved life cycle cost.
Smoother rides.
Thank You Questions?