Project Scoping
Presentation Outline

- Mix Selection
- Rehab of Concrete Pavements
- Preventive Maintenance
Mix Selection – Mix of Fixes

Capital Preventive Maintenance - (Crack Filling, Surface treatments, thin overlays)

Rehabilitation - Conventional overlays, Rubblization, ASCRL, Etc.

Reconstruction - Full depth pavement removal and replacement
Mix of Fixes

Capital Preventive maintenance: Shorter Term Fixes

- 1 ½” HMA Overlay
- Milling and 1 ½” HMA Overlay
- Crack Treatment
- Overband Crack Filling
- Chip Seal
- Micro-Surfacing
- Ultra-Thin HMA Overlay
Mix of Fixes

Rehabilitation: Medium Term Fixes

- Structural HMA Overlay (Multiple Course)
- Mill and Structural HMA Overlay
- In-Place Recycling
  - Crush and Shape
  - Cold-in-Place
  - Hot-in-Place
  - Full Depth Reclamation
- Rubblization
- ASCRL
Mix of Fixes

Reconstruction: Long Term Fixes

- Full depth pavement removal and replacement
- New Construction
Selecting the Right Mix

- Selection of Mix for:
  - Optimum Performance
  - Economics

- Binder Selection Economics

- Lift Thickness vs. Performance

- Use of RAP
Binder Selection

Example:

• 1 ½” resurfacing of existing road
  – 98% reliability binder grade is PG 64-28
• Consider using PG 64-22?
  – Reflective cracking
Lift Thickness based on Nominal Maximum Aggregate Size (NMAS)

NMAS – 1 size larger than the first sieve to retain more than 10%
# NMAS

## Table 2: Aggregate Properties

<table>
<thead>
<tr>
<th>Mixture No.</th>
<th>2C</th>
<th>3C</th>
<th>4C</th>
<th>13A</th>
<th>36A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 inch</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inch</td>
<td>91-100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 inch</td>
<td>90 max.</td>
<td>91-100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1/2 inch</td>
<td>78 max.</td>
<td>90 max.</td>
<td>91-100</td>
<td>75-95</td>
<td>100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>70 max.</td>
<td>77 max.</td>
<td>90 max.</td>
<td>60-90</td>
<td>92-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>52 max.</td>
<td>57 max.</td>
<td>67 max.</td>
<td>45-80</td>
<td>65-90</td>
</tr>
<tr>
<td>No. 8</td>
<td>15-40</td>
<td>15-45</td>
<td>15-52</td>
<td>30-65</td>
<td>55-75</td>
</tr>
<tr>
<td>No. 16</td>
<td>30 max.</td>
<td>33 max.</td>
<td>37 max.</td>
<td>20-50</td>
<td></td>
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<tr>
<td>No. 30</td>
<td>22 max.</td>
<td>25 max.</td>
<td>27 max.</td>
<td>15-40</td>
<td>25-45</td>
</tr>
<tr>
<td>No. 50</td>
<td>17 max.</td>
<td>19 max.</td>
<td>20 max.</td>
<td>10-25</td>
<td></td>
</tr>
<tr>
<td>No. 100</td>
<td>15 max.</td>
<td>15 max.</td>
<td>15 max.</td>
<td>5-15</td>
<td></td>
</tr>
</tbody>
</table>

*Ex: 4C mix – NMAS is ½”*
Local Agency Programs
Hot Mix Asphalt (HMA) Selection Guidelines
Rev: 06/14/2016 - FHWA Approval: 08/29/2016

The following guidelines have been developed at the request of Local Agency Engineers for use on Local Agency projects. These guidelines have been reviewed and approved by the County Road Association of Michigan Engineering Committee. Previous experience and performance shall permit variations from these guidelines as per Section D. Alternative Mixes.
## 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
Lift Thickness vs. Performance

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

• Lift Thickness Affects Compaction
  – Consolidation “Room”
  – Cooling Rate
Why Recycle RAP into HMA?

• Best and Highest use
• Same or better performance as virgin mix
• Reduces demand for new materials
• Reduces carbon footprint
• Contains valuable materials
• Save $
Why Recycle RAP into HMA?

- RAP contains valuable materials:
  - Aggregate ~ 94% @ $10/ton
  - Asphalt ~ 6% @ $320/ton
  - Value = $28.60/ton (minus processing)
## Economic Savings Example

- Aggregate: $10.00/ton
- Asphalt: $320.00/ton
- RAP: $9.00
- Mix Design AC Content: 6.0%

<table>
<thead>
<tr>
<th>Material</th>
<th>0% RAP</th>
<th>17% RAP</th>
<th>27% RAP</th>
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</thead>
<tbody>
<tr>
<td>Aggregate</td>
<td>$9.40</td>
<td>$7.70</td>
<td>$6.70</td>
</tr>
<tr>
<td>Asphalt</td>
<td>$19.20</td>
<td>$15.94</td>
<td>$14.02</td>
</tr>
<tr>
<td>RAP</td>
<td>$1.53</td>
<td>$2.43</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$28.60</td>
<td>$25.17</td>
<td>$23.15</td>
</tr>
<tr>
<td>$ Savings</td>
<td></td>
<td>$3.43</td>
<td>$5.45</td>
</tr>
<tr>
<td>% Savings</td>
<td></td>
<td>12.0%</td>
<td>19.1%</td>
</tr>
</tbody>
</table>
Recommended Practices for Use of RAP (and RAS)

Follow best practices for the processing and management of RAP

- Contractor to sample and test RAP during processing

RAP usage specification

- RAP mixes should meet same specs as virgin mixes
  - Adjust binder grade appropriately

Approved mix design including RAP
Recommended Practices for Use of RAP

Approved mix design including RAP

Know the properties of the RAP
• Gradation, binder content, theoretical maximum specific gravity

Mix design must be done incorporating RAP and taking into account the RAP characteristics
### Mix Design Example

**Michigan Department of Transportation from 1991**

**SUPERPAVE™ HMA Design Mix Formula**

**Distribution: Project Engineer (1) – TMI (1) – Mix Design (1) – Contractor (1) – Bit File (1)**

**Control Section:** B8X9 54038  
**Job Number:** 54321A  
**Project Engineer R. Steel P.E.**  
**Project Location: BIG RAPIDS**  
**Plant Location: TMI**  
**Plant No.: 701-91**  
**Mix Type:** SBE  
**Mix Design Number:** 665MD540  
**Project Location Specification:** 03SP501(F)

<table>
<thead>
<tr>
<th>Gmm</th>
<th>Gmb</th>
<th>2.359</th>
<th>Gb</th>
<th>1.029</th>
<th>Gsb</th>
<th>2.644</th>
<th>Gse</th>
<th>2.682</th>
<th>Film Thickness</th>
<th>7.21</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.6%</td>
<td>15.0%</td>
<td>26.0%</td>
<td>33.0%</td>
<td>1.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
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<tr>
<td>E</td>
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<td>I</td>
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<tr>
<td>J</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pit Number:** 54-101  
**Aggregates Type:**  
**Blend %:**  10.6% | 15.0% | 26.0% | 33.0% | 1.0%  
**% Binder of RAP:** 3.60  
**Plant:**  
**% AC:**  5.7  
**Combined:**  9.06%  
**% Binder of RAP:** 3.60  
**% New AC Added:** 5.16

**REMARKS:**  
Asphalt Binder Grade PG 64-28 A.C. Supplier I.D. # ASS 1095

**Bituminous Engineer**
Ability to Meet Volumetrics

- Treat RAP as mix component
- Challenges: VMA and dust/asphalt ratio
  - Good processing practices and quality control can be used to overcome this issue
Recommended Practices for Use of RAP (and RAS)

Test the produced Mix:
- (Binder, Gradation)
- Contractor Quality Control Tests
- Owner Quality Assurance / Acceptance tests

If you have performance concerns:
- Consider testing/monitoring other properties
- Mix volumetrics (Air Voids, VMA)
- Fines to Effective Binder Ratio
Presentation Outline

- Mix Selection
- Rehab of Concrete Pavements
- Preventive Maintenance
Rehabilitation of Concrete Pavements

• Improve ride quality
• Correct surface defects
  – improve surface drainage
  – increase surface friction
• Delay/prevent structural deterioration
• Strengthen pavement structure (rehabilitation)
Rehabilitation Design Factors

- Condition of existing pavement
  - Drainage
  - Distress
  - Response to load
- Foundation strength/stiffness
  - Subbase
  - Subgrade
- Future traffic loading
- Additional corrections (safety, capacity, etc)
Reflective Cracking

- By far, the biggest issue in HMA overlays of PCC pavement
- Caused by movement at PCC joints and cracks
Design Issues

- Rate of propagation through overlay
- Number of reflected cracks
- Rate of deterioration of reflected cracks
- Amount of water that can infiltrate through the cracks
Reflection Crack Control Measures

- Fabrics
- Stress-relieving interlayers
- Crack-arresting interlayers
- Pre-overlay treatments
- Slab repair or replacement
- Sawing and sealing joints
- Increased overlay thickness
Crack Control Effectiveness

- Delay the occurrence of cracking
- Reduce the number of cracks
- Control the crack severity
- Provide other benefits
  - Reduce overlay thickness
  - Enhance waterproofing capabilities
Fabrics

Overlay

Old pavement

Subgrade Soil

Fabric

Stress concentration

Horizontal opening

Vertical differential Movement
Fabric Application
Pre-overlay Repairs

- Slab stabilization
- Fractured slabs
- Slab repair / replacement
- Load transfer restoration
Fractured Slab Techniques

- Crack and seat (JPCP)
- Break and seat (JRCP)
- Rubblize (JPCP, JRCP, CRCP)
Cracking and Seating

• Shortens effective slab length
• Standard practice in many States
• Not “generally” recommended for use on poor subgrades
• Design methods (overlay thickness)
Cracking and Seating

- Overlay
- Cracks
- Short slab length (~2’)
- Good granular interlock

Subgrade Soil
Subbase
Firm Foundation

Asphalt Pavements – America’s Most Recycled Product
Cracking and Seating
Cracking and Seating
Rubblization

• Fracturing:
  – Eliminates slab action
  – Destroys bond between concrete and steel

• Rubblized base responds as a tightly keyed, interlocked high-density, unbound layer
  – Layer cannot crack; already fractured
Why Rubblize?

- Fracturing PCC to segments less than 9” precludes reflection of:
  - Joints
  - Cracks
  - Faults
- Production Rates up to 1 lane-mile/day
Rubblization

Smaller Pieces = Smaller Movement = No Cracking

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Rubblerization - Equipment

Resonant Pavement Breaker

Multi-Head Breaker (MHB)
When to Rubblize

- Patching > 10%.
- Severe D-cracking.
- Severe ASR or ACR cracking.
- Dowel bar locking
- Severe joint deterioration
- Persistent faulting.
Precaution

- Weak soils may make construction difficult.
- Option 1
  - Adjust breaking pattern (12 - 18") in soft areas.
  - Use normal seating rolling.
  - Resume smaller pattern after weak area.
Precaution

• Option 2
  – Cease rubblization
  – Define weak area
  – Remove/replace problem material
  – Resume normal operations when past weak area
• Perform a good soils evaluation prior to construction
Stress-Absorbing Interlayers

- Overlay
- Membrane
- Old pavement
- Subgrade Soil

Stress concentration
Horizontal opening
Vertical differential Movement
Asphalt Stabilized Crack-Relief Layer (ASCRL)

- HMA Overlay
- ASCRL
- High voids
- Old pavement
- Subgrade

Asphalt Pavements – America’s Most Recycled Product
Asphalt Stabilized Crack-Relief Layer (ASCRL)
Asphalt Stabilized Crack-Relief Layer (ASCRL)

HMA Overlay, 3.5” – 4”

ASCRL 3” – 3.5”

Old pavement

Subgrade
Asphalt Stabilized Crack-Relief Layer (ASCRL)

MICHIGAN DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
ASPHALT STABILIZED CRACK RELIEF LAYER

1. Description. Furnish, place and compact an asphalt stabilized crack relief layer (ASCRL) on a prepared pavement base according to the details shown on the plans or as directed by the Engineer. The HMA mixture will be provided according to the requirements of the 2003 Standard Specifications for Construction, except where modified herein.

2. Materials. The aggregate materials used to prepare the ASCRL shall meet the following requirements:

   a. The coarse aggregate shall originate geologically only from natural sources. Crushed concrete or reclaimed asphalt pavement cannot be used in the ASCRL mixture.

Table 1 Aggregate Specifications

<table>
<thead>
<tr>
<th>Gradation Requirements</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size (inch)</td>
<td>1 1/2</td>
<td>1</td>
<td>1/2</td>
<td>No. 4</td>
</tr>
<tr>
<td>Percent Passing</td>
<td>100</td>
<td>98-100</td>
<td>100-95</td>
<td>90-85</td>
</tr>
</tbody>
</table>

Physical Requirements

| Crushed Material, Min. (MTM 117) % (b) | 95 |
| Loss max. Los Angeles Abrasion (AASHTO T169) % | 35 |
| Soft Particle (max) % (c) | 5.0 |

3. Mix Design. The Contractor shall provide a mix design in accordance with the criteria herein. The following are the requirements for the testing, documentation, and material samples for a mix design verification. Submission of the Mix Design and samples shall be made to MDOT.

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SMOOTH | DURABLE | SAFE | QUIET
## Asphalt Stabilized Crack-Relief Layer (ASCRL)

<table>
<thead>
<tr>
<th>Table 1 Aggregate Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation Requirements</td>
</tr>
<tr>
<td>Sieve Size (inch)</td>
</tr>
<tr>
<td>Percent Passing</td>
</tr>
</tbody>
</table>

Asphalt Pavements – America’s Most Recycled Product
Asphalt Stabilized Crack-Relief Layer (ASCRL)

<table>
<thead>
<tr>
<th>Physical Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushed Material, Min. (MTM 117) % (b)</td>
<td>95</td>
</tr>
<tr>
<td>Loss, max., Los Angeles Abrasion (AASHTO T96) %</td>
<td>35</td>
</tr>
<tr>
<td>Soft Particle (max) % (c)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

a. Loss by Washing shall be by MTM 108. Mineral filler may used to meet the required percentage.
b. The percentage of crushed material will be determined on that portion of the sample retained on all sieves down to and including the No. 4 sieve.
c. The sum of aggregate particles retain on the No. 4 sieve identified as shale, siltstone, clay ironstone and particles which are structurally weak or are found to non-durable in service.
Asphalt Stabilized Crack-Relief Layer (ASCRL)

Mix Design

- Asphalt Binder – PG 64-28 with 0.5% liquid antistrip additive
- Asphalt content – 3 to 4 %
- Surface Coating – 100 % without excessive draindown (max 0.30 %)
- Minimum Asphalt film thickness - 9.0 microns
- Moisture sensitivity (AASHTO T283)
Asphalt Stabilized Crack-Relief Layer (ASCRL)

Construction

• Placed in a single layer
• Compaction – steel – wheeled tandem roller (1.0 ton per foot of drum length)
  • Static mode only
  • Minimum of three passes (down and back)
  • Compaction test strip may be required (minimize breakage of Agg.)
Asphalt Stabilized Crack-Relief Layer (ASCRL)

MDOT Projects to Date

<table>
<thead>
<tr>
<th>Project</th>
<th># of Jobs</th>
<th>Length (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCRL</td>
<td>44</td>
<td>150</td>
</tr>
</tbody>
</table>

Started in 1999
- All are performing very well
Asphalt Stabilized Crack-Relief Layer (ASCRL)

M-21, Before Construction
Asphalt Stabilized Crack-Relief Layer (ASCRL)

M-21, 3 years old
Sawing and Sealing Joints

- Concede appearance of reflection cracking
- Objective: control rate of deterioration
- Reduces spalling of reflection cracks
- Candidates should have well-defined joints
- Sawcut must be directly above underlying joint
Sawing and Sealing Joints

- Overlay
- Reflection crack
- Old pavement
- Subgrade
- Sealant
- Initial sawcut 1/3 depth
- Horizontal opening
- Vertical differential movement
- Joint reservoir

Asphalt Pavements – America’s Most Recycled Product
Sawing and Sealing Joints
Increased Overlay Thickness

• Delays occurrence of reflection cracking
• Cracks propagate about 1 in. per year
• Reduces temperature fluctuations in underlying pavement
Presentation Outline

• Mix Selection
• Rehab of Concrete Pavements
• Preventive Maintenance
Preventive Maintenance

WHAT EXACTLY IS YOUR PREVENTIVE MAINTENANCE PROGRAM PREVENTING?
Preventive maintenance is a planned strategy of cost effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without substantially increasing structural capacity.
Preventive Maintenance

Standard Capital Preventive Maintenance Treatment
Pavement Seal

- HMA Crack Treatment
- Overband Crack Fill- Pretreatment
- Chip Seals
- Micro-surfacing
- Ultra-Thin HMA Overlay-Low & Medium Volume (<1” thick)
- Shoulder Fog Seal
- Paver Placed Surface Seal
Preventive Maintenance

Crack Treatment
Preventive Maintenance

Chip Seal
Preventive Maintenance

Micro-surfacing
Preventive Maintenance

HMA Ultra-Thin
High Value Pavement Enhancement

Extends pavement life
Protects pavement structure
Restores pavement smoothness

Asphalt Pavements – America’s Most Recycled Product
HMA Ultra-Thin

3/4” to 1” Thickness

Asphalt Pavements – America’s Most Recycled Product

SMOOTH | DURABLE | SAFE | QUIET
HMA Ultra-Thin

BENEFITS
• 5-9 year life extension
• Seals pavement to delay further deterioration
• Improve ride quality
• Minimize or eliminate structure adjustments
• Reduce noise
• Improve drainage
• Ease of construction, standard paving operation
• Minimal construction time
HMA Ultra Thin

PASER Manual for Asphalt Roads

4 – 6 Paser rating
## HMA Ultra-Thin Performance

### MDOT Projects - Statewide

<table>
<thead>
<tr>
<th>UT Type</th>
<th># of Jobs</th>
<th>Length (miles)</th>
<th>Avg. Age (end service)</th>
<th>Avg. Age (in service)</th>
<th>Avg. Age (overall)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-thin low</td>
<td>52</td>
<td>483</td>
<td>7.6 (20)</td>
<td>9.8</td>
<td>8.6</td>
</tr>
<tr>
<td>Ultra-thin med</td>
<td>41</td>
<td>339</td>
<td>5.5 (4)</td>
<td>8.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Ultra-thin high</td>
<td>16</td>
<td>89</td>
<td>5.3 (3)</td>
<td>7.3</td>
<td>6.4</td>
</tr>
</tbody>
</table>
# HMA Ultra-Thin Statewide

## Preventive Maintenance Treatment Cost Comparison

<table>
<thead>
<tr>
<th>Treatment</th>
<th>$/syd</th>
<th>Cost/mile (24’ wide)</th>
<th>MDOT Life extension range (years)*</th>
<th>MDOT Life extension range average (years)*</th>
<th>Cost/mile* per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double chip seal</td>
<td>$3.18</td>
<td>$44,773</td>
<td>3-5</td>
<td>4</td>
<td>$11,193</td>
</tr>
<tr>
<td>Micro-surface</td>
<td>$2.61</td>
<td>$36,747</td>
<td>3-5</td>
<td>4</td>
<td>$9,187</td>
</tr>
<tr>
<td>Ultra-thin low</td>
<td>$2.51</td>
<td>$35,339</td>
<td>5-9*</td>
<td>9*</td>
<td>$3,927</td>
</tr>
<tr>
<td>Ultra-thin med</td>
<td>$2.87</td>
<td>$40,408</td>
<td>5-9*</td>
<td>8*</td>
<td>$5,051</td>
</tr>
<tr>
<td>Ultra-thin high</td>
<td>$3.29</td>
<td>$46,321</td>
<td>5-9*</td>
<td>7*</td>
<td>$6,617</td>
</tr>
</tbody>
</table>

*Average Life Extension estimated by APAM  
Unit Prices based on MDOT Information (thru Jan. 2016)
## HMA Ultra-Thin

<table>
<thead>
<tr>
<th>Feature</th>
<th>HMA UT</th>
<th>Chip Seal</th>
<th>Microsurfacing</th>
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</thead>
<tbody>
<tr>
<td>Increase skid resistance</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Minimizes curb loss</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Corrects surface distress</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Can be applied in one pass</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Increases structural strength</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improves ride quality</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improves pavement draining</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrects minor rutting</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Eliminates dust, loose aggregate</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Advantages:

• Adds structural value
• Very smooth riding surface
• Improved ride quality
• No excess stone buildup
• No broken windshields from loose aggregate
Project Scoping

Questions?